SOME ACCOUNT OF THE MODELS OF CHURCHES PRESERVED IN HENRY V's. CHANTRY, WESTMINSTER ABBEY.

BY PROFESSOR DONALDSON. (WITH A PLATE.)

(Read before the Institute of British Architects, 6th Nov., 1843.)

There are in all thirteen models of churches, built or, as it is supposed, intended or proposed to have been built, under the grant of Queen Anne, when a sum of money was voted for the erection of forty churches. Three of these are those of Greenwich, St. John's, Westminster, and the New Church in the Strand. The other ten have not been executed. These models are of wood, with the architectural features made out with considerable care, and the whole of the internal fittings, even to the font, are accurately and minutely modelled, and are easily seen, as the roofs are fitted with hinges, so as to lay open the interior for that purpose.

These models are made of wood, and, although they were at one time exposed to all visitors to this part of the Abbey, are not very materially injured, so that they might be repaired, cleaned, and varnished at very little cost. I could not ascertain when or why they were deposited in the Abbey, and there are no inscriptions upon them to indicate the name of the architect, the date, or destination of the churches. The absence of this information is much to be regretted, for they are really a fine set of models, the style of art imposing, and there is a sumptuousness of effect and nobleness of parts, which make one regret that we have lost so many edifices, which would have been great ornaments to the metropolis, and would have tended to raise the character of our architectural taste. It will be perceived that two of the designs are models of hexastyle temples: one Ionic, having six columns in front and rear, and ten on the flanks; the other Corinthian, with six columns in front and rear and twelve on the flanks,—a splendour of architecture which has never been realised for churches in this country, and which, if executed, would in point of date have given us priority over the Madeleine at Paris. Most of the models are strongly indicative of the Wren and Vanburgh schools of that period.

It is extremely to be regretted, that these models are placed where they cannot be seen, for they are not now shown to the public, and in fact, the chantry is limited in space, out of the way, and only reached by ascending the narrow spiral staircase at the angles, up which it would be inconvenient for the public to go. Consequently, the practice of allowing the groups of visitors to go up there has been discontinued for many years.

The following is a list of these churches, with the leading dimensions of the size of each model:—

No. 1.—Model of Greenwich church, without the tower; 2 ft. 2 in. long, and 1 ft. high.

No. 2.—Model of St. John's church, Westminster; 1 ft. 10 in. long, and 15 in. high.

No. 3.—Model of the New Church in the Strand; 2 ft. long by 1 ft. wide; total height of tower, 2 ft. 7 in.

These are the churches which have been erected; the following are models unexecuted of churches whose destinations are unknown.

No. 4.—One of the Doric order, with a 6-columned portico in front, and a 4-columned ditto on the north and south sides; 3 ft. 4 in. long and 11 in. high, surrounded by an ample court or yard enclosed by pedestals and iron railing. The entrance to the court is under a fine square tower considerably in advance of the church, 7 in. square and 19 high, very much in the character of Vanburgh's style.

No. 5.—A rusticated Doric portico of six columns, projecting one intercolumniation. The whole forms a parallelogram with pilasters on the flanks. The rear has a recessed central porch, formed of four pilasters and two columns, as at Greenwich. This model is 18 inches long by 14½ wide; there is one plinth step ⅞ of an inch high; the order is 8½ inches high, and to the apex of pediment of front portico 11½.

No. 6.—One model of Roman Doric has a very peculiar general arrangement of plan,—a semicircular apsis at the east end, with wings or transepts as it were. Then there is a simple parallelogram for the body of the church, and the wings or transepts are repeated at the west end, beyond which a projecting compound portico forms the west end, which can only be explained by plan. There is not any pediment over the portico; the height of the order is 8 inches; the total length of the model is 42½ inches, width 13½ inches.

No. 7.—This model is of Roman Doric, with a hemicycle on the east end, flanked by two arms or transepts. There is a 2-columned portico on each side to a central door. The front forms an hexagonal disposition, composed of four pilasters and two central columns, with recess formed by the three central intercolumniations, as at Greenwich. Total length without the absis, 2 ft. 1½ in.; total width, 16 inches; plinth, ⅞ in. high; order, 8 inches high; a square tower, 23 inches high from the ground.

No. 8.—An oblong church in plan of a fine bold Roman Doric. The central parallelogram 23 inches by 18, with projections at each end for the communion place and steeple, giving a total length of 2 ft. 7 in. The plinth is 1 inch high, the order 9¼; the steeple 3 ft. 2 in. high.

No. 9.—This is an imitation of a hexastyle peripteral Ionic temple, with six columns in front and twelve on the flanks. There is a lofty steeple, rising over the pediment of the front portico at a short distance from the front. A flight of steps leads up to the portico. The steps form a total height of 1½ in., the order 11½ in. high; to top of pediment 16 inches. Total width, 22 inches; total length, 47 inches.

No. 10—Is a square church, of rusticated Corinthian. In front is a central tetrastyle portico, surmounted by a pediment, flanked by side porticoes of coupled columns slightly receding from the face of the portico, so as to give effect to the principal feature; but there is much confusion in this irregular disposition of the columns. There is a tower flanking each side of the pediment. The general dimension of the block plan is 19 inches by 15; the order is 7½ in. high, raised upon a pedestal 1½ in. high.

No. 11.—An exact imitation of a Corinthian hexastyle pseudo-peripteral temple, with 6-columned portico in front, projecting one intercolumniation, and surmounted by a pediment, with 10 attached columns on the flanks. The columns stand upon a podium or pedestal 21 inches long and 15½ wide; height of order 7½ inches.

No. 12—Is a very large model, of the Corinthian order. The plinth 1½ in. high, the order 12 inches, and total height from the ground to apex of pediment 17½ inches. It is 4 feet long, and 1 ft. 11 in. wide. The general form is that of a parallelogram. The front represents a tetrastyle or 4-columned disposition, with coupled columns, having a pediment over them, and a tower at each of the four angles of the parallelogram. One side of the flanks is plain, but the other is enriched, and produces a fine effect.

No. 13.—A circular church, 20 inches in diameter.

It is to be presumed that the whole of these models are made to an uniform scale of one quarter of an inch to a foot.

There is, in addition to these 13 models of churches of Roman architecture, another fine wood model of the Crux of Westminster Abbey, three arches of the nave, and a great part of each transept, showing the section of construction, with a lofty tower and spire over the crux. The width from outside to outside of the nave aisle walls is 2 feet, the height from the pavement to the roof of nave in the model is 2 ft. 4 in., and the height to the top of the spire is about 5 feet. This is apparently the model used by Sir Christopher Wren to study the practicability of raising the central tower, and putting a lofty spire thereon, an idea which, if practicable, seems more than ever desirable now, if the Abbey is to maintain its pre-eminent loftiness in this part of the metropolis, as the splendid tower of the New Houses of Parliament will totally eclipse the towers of the Abbey, both in magnificence and altitude. The construction through the pillars, walls, buttresses, arched roofs, and the wooden framing of the nave roof are very accurately made out, rendering this model a very interesting object of study to the architectural student.

ON FRESCOES.

A LETTER FROM MR. J. S. CRACE TO PROFESSOR DONALDSON. READ BEFORE THE INSTITUTE OF BRITISH ARCHITECTS, *6th Oct.* 1843.

DEAR SIR,

I WILLINGLY accede to your request to give you some account of the frescoes that have fallen under my notice during a recent tour in Germany and the North of Italy; but, in doing so, I beg you to consider that the opinions I give, I offer merely as what I myself think, without intending to intrude them as opinions of any worth.

In Italy, Switzerland, and the South of Germany, I found the paintings in fresco so general, that there is scarcely a town in which, both on the exterior and in the interior of the houses, some are not to be met with.

In Italy this kind of decoration is the most frequent—*there*, in many cases, the architectural effects seem to have been arranged with the view of being afterwards aided by painting; the enrichments of the mouldings, and the ornaments, being often given in chiaro-oscuro; and in other cases the whole wall being covered with historical or allegorical and ornamental painting.

My principal object in travelling was, firstly, to learn the processes employed in fresco and encaustic painting; secondly, to form an opinion as to the effects produced; and, thirdly, to judge how far those effects would surpass painting in oil, in *appearance* and *durability*. For the two first reasons it was, therefore, the more modern specimens of the art to which my attention was principally directed.

At the Royal Palace at Venice, I noticed decorations lately executed in fresco; but it was at Munich that I saw the art most extensively employed. In this city it is to be met with in every modern public building. In the church of St. Louis is the grand painting of the Last Judgment, by Cornelius, and other frescoes of considerable merit by his pupils; in the All Saints Chapel are beautiful paintings by Hess and his pupils, on a gold ground; at the Basilica of St. Bonifacius, so splendidly decorating, Hess and others are employed, at this time, on a series of grand paintings; at the Glyptothek are the frescoes of Cornelius; at the Pynacothek those by Zimmerman and others; and at the two Royal Palaces each room is adorned by some artist of excellence, either in fresco or encaustic. In addition to these interiors, there are examples of exterior decoration at the Hof Garden, the façade of the Post Office, and the Theatre.

The process of painting in fresco, though attended with certain difficulties, is easily learnt with ordinary perseverance.

The effects produced surpass paintings in oil in *solidity* and *clearness*, but, owing to the limitation of colours employed, there always appeared to me a certain yellow brown dry effect, and a want of the richness of paintings in oil. In the grand fresco by Cornelius, of the Last Judgment, I think this must be felt by all; and in the beautiful subject by Veith, at Frankfort, this defect is still more apparent.

The manual operation I found, to my surprise, to be by no means rapid, even by the practised hands: one of the most distinguished artists, I noticed, painting a broad fold in the drapery of a monk; he used a small brush, and gained his effects by repeated touches, more slowly than in oil. The ground of lime and sand requires to be touched with delicacy. The pictures executing at the Basilica take, I was informed by one of the artists, nearly a twelvemonth each to execute. The cartoons and pounces are prepared in the winter months, and the painting is done during the summer. These are certainly very beautiful works, and all the details are most accurately made out. In ornament, too, I observed that the work was not quicker than in oil, and slower than in distemper, to which it is superior as bearing washing, but inferior in the brilliancy of colouring.

As to the durability of fresco,—in the older examples that I noticed in Italy, though the paintings had preserved to a considerable extent their original colouring, yet the effect was in almost all cases impaired by the decay of the plaster ground, the surface of which had crumbled through the action of the atmosphere. At Venice, where works on a grand scale have been executed, in both fresco and oil, I was curious to compare the relative defects and advantages of each, and found that, though the paintings in oil of some masters had much darkened, yet with others, particularly Paul Veronese, the effects were still clear and fresh, and upon the whole, being in better preservation, surpassed the actual appearance of most of the frescoes.

In the grand works lately executed at Munich, they have been too recently done to allow of an opinion being formed; yet in the exterior specimens at the Post Office and the Hof Garden signs of decay are very evident.

Upon the whole, reflecting on all I saw, considering the difficulties of execution, the liability of decay in the ground, and the impossibility of reparation if injured, I could not perceive any great advantage over oil: in this country must be further added the additional likelihood of decay from our damp climate, and discolouration through smoke and fog.

On the one side it has great advantages in being seen to perfection in all lights, and therefore particularly desirable for painting architectural effects in chiaro-oscuro; in its clearness and the soundness of its colours. On the other side are the disadvantages I have enumerated above.

I am, dear Sir,
Your obedient Servant,

3rd November, 1843. JOHN S. CRACE.

ON THE PRESENT STATE OF THE AIR OF RAVENNA;

WITH A DESCRIPTION OF THE DRAINAGE OF THE CITY, AND OF OTHER PROVISIONS FOR THE PUBLIC HEALTH.

(FROM A REPORT BY ZENDRINI, IN THE YEAR 1731. ADDRESSED TO CARDINAL MASSEI.)

ONE of the points which we here propose to investigate is that of a better arrangement of the drainage of the city, which is now, by a long course, discharged into the sea through the canal of Fossina; and as the salubrity of the air depends upon the proper condition of this drainage, we may be allowed, in passing, to make a few remarks upon the general state of the atmosphere, and to trace the effects which will probably be produced by the projected regulation of the waters in the drain, and by other useful provisions directed to the same end.

It is evident that this subject would furnish sufficient matter for an entire treatise, instead of a short chapter in this relation. But, that we may not go beyond the limits we have fixed, we shall only present to your Eminence some leading principles regarding the state of the air; and, without attempting to investigate the nature of this element, we shall merely say that it is a homogeneous fluid, and that by terrestrial evaporations a change is produced in this universal and perfect medium,—a medium destined by nature for the support of all animal life.

The ancients in their writings frequently urge the necessity of building cities and habitations in the situations best calculated to insure the health of the inhabitants; and Vitruvius, in his work on Architecture (lib. i. c. 4), states, that Ravenna, which he calls a very large city, was among the best situated and the most salubrious in the Roman states. "Exemplar autem hujus rei Gallicæ paludes possunt esse, quæ circa Altinum, Ravennam, Aquileiam, aliaque, quæ in ejusmodi locis municipia sunt, proxima paludibus, quod his rationibus habent incredibilem salubritatem."

So Hippocrates, the restorer of medicine in his day, or whoever that learned philosopher may have been who wrote the Treatise on "Air, Water, and Place," gives us many precepts by which to ascertain the salubrity of the air, so that any one can easily understand the nature of those causes by which alterations are produced in it.

We need not enter further into this subject than to state, that the air of any place may be contaminated either by exhalations produced

upon the spot, or brought from a distance. In the former case it arises from the qualities of the ground; either from minerals, stagnant waters, or marshes, from accumulations of refuse or filth, and other substances liable to decomposition, and the most volatile parts, being separated, are imbibed by the air.

The impurities of the air resulting from distant causes, although produced from the same agency, are brought by the winds into one place more than another, and that one place becomes the subject of all the injurious effects of the contamination. But a third cause may operate against the purity of the atmosphere in some situations, and that is, a greater exposure to the pernicious than the healthy winds. It is a common saying, that air must be ventilated to be healthy, and as the course of rivers is a good means for this purpose, those cities and places which are situated near running waters, or on the shores of the sea, which is always in motion, are considered to have a very salubrious atmosphere.

Ravenna is at present about five miles from the sea, with the river Montone on the west and north, and with the Ronco on the south from the gate Samammo as far as the new gate, but on the east it has the two before-named rivers, which form their confluence, at a very acute angle, 350 pertiche from the wall, so that the south-eastern portion of the city is the only part not surrounded by the rivers: this is the part called *di mezzo i fiumi.*

In consequence of the elevation of the above-named rivers it has been necessary, to prevent the town from being inundated at every flood, to raise their banks, which pass very near a military trench left round the walls and ramparts, and the plane of the city is thus reduced so low, that on the three sides we have mentioned it may be said to be entirely buried.

In addition to this it may be stated, that the base of the bank has been spread so much towards the ditch, in consequence of its great elevation, that the ditch itself is in many places so narrow that the water has become putrid; and as some of the branches of the public drains which fall into it meet with great obstructions from the vegetation that encumbers it, as well as filth, bricks, and stones, we may say that the city is for the greater part surrounded by the most putrid and pernicious collection of substances that can be imagined. I happened to pass, at the setting of the sun, out of the gate Serrata, and I saw with great astonishment a thick fog rising from the dark ditch, an evident sign of the great exhalation that proceeds from it, to the serious injury of the health of the inhabitants. It is true that towards the side of the confluence of the river, and towards the Senseda, the banks of the river are at a distance from the walls, and the air ought to have a more free passage, and give circulation to the air of the city. But it is also true that that fertile space of ground is so much covered with the thick foliaged trees of the country, that the necessary communication is too much intercepted and impeded.

The south-eastern is the only part that is open, and the space is here also so much encumbered by trees, that it cannot enjoy the free circulation of the wind from that quarter, which it would otherwise sometimes receive. But still the best air of the city is towards the archbishop's palace at the gate Sisi, and in the adjacent parts, but this may be partly attributed to the greater elevation of the ground.

In the time of Strabo, as he informs us in the fifth book of his geography, the air of Ravenna was considered one of the most salubrious in Italy, and in proof of this he states that the gladiators and athletæ were educated here. "Hoc pacto igitur saluberrimus comperitur locus. Unde gladiatoribus educandis, ac exercitatione erudiendis hunc idoneum magistri locum designaverunt." And all this was produced by the motion and intermixture of the waters of the sea with those of the river, by which the air was purged from the pernicious vapours of the marshes; but now, far from the sea, the rivers have been compelled to raise their beds to discharge their waters, and Ravenna has lost, with its salubrious climate, the best source of its happiness.

But supposing that the city should be in many parts exposed to the winds, which could remove every evil influence that arises within its boundary, it would still remain to be determined whether those winds, instead of carrying away pernicious evaporations, may not bring others as bad or worse.

We must not consider the quality of winds, that is to say, an alteration in the atmosphere affecting the health of men, simply as a deranged motion of that element produced by rarefaction or condensation in some distant part, but we must also regard their direction and tendency. Thus, for instance, the silocco, which in this part of Italy is humid and relaxing, is dry on the north coast of Africa, and on the contrary the north wind is there humid and unhealthy. The different characters of the marshes, seas, or land over which the winds pass contribute to them one or the other quality, and render them either healthy or pernicious.

Ravenna, on that flank where the Montone defends it, is exposed to the winds which blow from the north. This wind, passing over the great extension of the valleys of Comacchio, Longastrino, Savarna, and Palazzonolo, is very insalubrious in Ravenna, though not so in other countries; and if they blow at certain periods when the exhalations are abundant, the air of the city will be affected, and so much the more because the high banks of the Montone prevent the air within the walls of the city from a free circulation, and in a state to receive all the injurious effects of these exhalations.

The north-east and easterly winds are less pernicious, although humid, for they come directly from the sea and from the mountainous Dalmatia, although the Senseda, and perhaps also the Pigneta, standing on that side, may injure their salubrity. The south wind, which crosses a part of the gulf, and the valleys of Masullo and Candiana, must also be numbered among the pernicious winds, and especially as the north-west and north winds in the Montone meet the heights of the banks of the Ronco, in the line which extends from Samammo to Porta Nuova.

The south-west wind would not be pernicious if uncontaminated by the more distant marshes, but it also meets with an obstacle in the lines of the Ronco. Hence, then, the south wind, coming from the Apennines, must be considered the only healthy one, but this, being comparatively rare, cannot counteract the injurious effects of the other winds, which are almost constantly blowing.

In respect to the influence of the current water of the rivers in producing the ventilation of the air, it cannot be denied that the effect of their flow is to keep it in motion, and to purge it from the produce of evaporation, but it is desirable that for so large a city, and one situated so low, the motion should be greater; not that the inclination of the rivers is small, but in regard to the body of water, which is generally reduced in a few days after a flood almost to nothing, their course is almost momentary, and the air is in consequence very humid, but above all in consequence of the high banks the air is not so much benefited by the course of the flood as might be expected. Still the atmosphere of Ravenna would be in a worse state if there were no river, or only a distant one. We have, therefore, in accordance with the opinions of the most eminent physicians, considered it most for the public advantage, not to remove the river,

in our plans, far from the city, the distance of our line not exceeding 300 pertiche from the bed of the Ronco, near to the Porta di Sisi.

If, in addition to this, we reflect that a continual stream of clear water is to be brought from the mills into the new navigable channel, it must be quite certain that the distance of the rivers will not in the slightest degree prejudice the city, but on the contrary greatly increase its salubrity, after the diversion of the rivers, if one of the most important obstacles to the circulation of the air be removed, that of the banks,* which are now of necessity kept to such a great height that the air is quite stagnant, and thus rendered prejudicial to the inhabitants.

As the present height of the banks will be unnecessary after the diversion of the rivers, they may be reduced some feet lower than the walls of the city and the ramparts, by which means a passage will be made for the circulation of the air, and the injurious effects resulting from the evaporation will be in a great degree removed.

But little, in comparison to the wants of the city, would be done if there were not some provision for effectual drainage. This has, under good advice, been partly done by a capacious subterranean sewer, running from one side of the city to the other, and receiving numerous transverse drains, by which the filth and rain-water is brought from every part and discharged into the sea.

As the elevation of the bed of the Montone prevents the free passage of this sewer, the river is crossed by a curved ponte canale, which has given its name to the conduit. The discharge of the sewer is at present in the Fossina, which the alluvions of the Lamone have so much prolonged into the sea, that the drainage of the sewer has lost much of its original fall. Still it appears from the levels we have taken, that the surface of the sewer at the Ponte Canale is 1 ft. 8¾ in. higher than the low tide, and as the tide rises only 1 ft. 2¾ in., there is still a fall of 6 inches, which could not be considered insufficient if the bed of the drainage were clear, but it is too small when considered in reference to the impediments it presents and the narrowness of the channel.

This drainage, instead of falling at Fossina, should discharge itself by a shorter and more certain course, and without the impediments it meets with from the Ponte Canale, to the sea, and for this purpose it should pass through the bed of the Montone, without any further use of the Ponte Canale. This sewer must either be brought into the Montone through the abandoned bed a little above the Ponte Canale, or, keeping the same origin, it must be conducted into the bed of the Ronco, or into the new navigation through the ancient bed now for an age abandoned, by the same Montone, which bends toward the Senseda, and enters, with a direct course, through the left bank of the Ronco.

But, although this operation would be of great consequence, it would not be sufficient if two other things were left undone. The first is, to remove all the impediments to drainage, such as the trees, foliage, and other matter, which everywhere encumber the bed. The second is, to open from time to time, without waiting for the fall of rain, which is somewhat rare, the sink opportunely placed a little above the old mill, the water of which would quickly remove the accumulations which, with so much prejudice to the air and to the public health, prevent within and without the city a perfect drainage.

* The rivers have been diverted, and are now flowing in their new channels; but the banks have not been lowered, although it is quite necessary for the ventilation of the air of Ravenna that these should be reduced to at least the height of the walls of the city.

THE NELSON MONUMENT,

OR

THE CENSORIOUSNESS OF SCULPTORS.

The Sculptors are either a very censorious or a very stupid class of British artists. As no one acquainted with the many beautiful works they have produced can believe the latter supposition, every one must admit the former, or deny my proposition, which is impossible. Much has been said about the National Gallery—its meanness of design, its want of elevation, and its indescribable detail; for no sufficiently degrading adjective has yet been discovered to characterise the features of our national depository of art. Many sharp things have been written in accusation, and a plea has never yet been presented by the defendants, so judgment must, I suppose, be given in default. But Britannia herself has been selected by the sculptors to judge this matter between the public, the plaintiffs, and some architectural critics, the defendants, and she has accordingly been raised to the summit to give judgment. Her situation is most distressing. Look at her downcast eyes, her most pitiful, shamefaced, desponding aspect! She entreats the passers-by to withdraw their claim upon her impartial judgment; but all that they can do is to exclaim—How art thou fallen among the Gods, by thy elevation, oh Britannia! Who but a censorious sculptor could have placed such a Britannia upon the National Gallery?

A high column has now been raised before this building, and the sculptor has been again called to find for it a fitting figure. Would that the base of the column could have been made big enough to have enclosed the National Gallery. But, alas! it is not so! It is only "a little go" fixed before the portico. Look and laugh, citizens and west-enders'—What could have been more appropriate for the top of a column, and that before the National Gallery, than an imperfect man—for surely a man without an arm is not less an object of admiration than a column 150 feet high raised to support him. Oh, naughty, censorious Mr. Bailey! Who but a sculptor could have imagined such a figure, cocked-hat and all, for such a situation. Still it must be admitted that these sculptors have a great notion of propriety, with all their perverseness and fun. If they happen to model a rich merchant who has risen from obscurity to eminence, from a cart to a carriage, from a hut to a palace, they are sure to fix him in some ungainly awkward position, the very identification of what he was rather than what he is. But, trace them when and where you will, it is all the same. What can be the cause, if it is not censoriousness?

S. S.

ON THE SEVERAL SPECIES OF FIR TIMBER AND DEALS SUPPLIED TO THE ENGLISH MARKET, AND THEIR RESPECTIVE QUALITIES FOR THE PURPOSES OF BUILDING.

(*Read before the Institute of British Architects, by G. Bailey, Esq., Secretary R.I.B.A., &c., on the 20th Nov. 1843.*)

In the practical part of the profession of an architect, and especially in those branches which occupy by far the greater portion of the time and labour of most of us, the security of our foundations is certainly the *most* important object to which we have to direct our attention,—the *second in importance* is undoubtedly the choice of our timber.

The properties of the various descriptions of wood coming under the denomination of timber,—their relative strength and durability,—their fitness for the various purposes of building with regard to their stiffness in different situations and under different conditions, have all been treated scientifically and practically, in a manner highly useful to the architect, and the results have long been in our hands.

The attention of the profession has even been called, both in ancient and modern works, to the planting, growth, and felling of timber, and the varieties which local circumstances and soil may produce in the same species. That information of this kind is in the highest degree useful to the architect, and indeed indispensable to be known, is not to be doubted, and the important practical results which may be derived from inquiries strictly scientific, must be familiar to all of us, who on a former occasion have had the pleasure of listening to the botanical discourses of our friend Dr. Dickson; but in the ordinary routine of our profession it is seldom (comparatively speaking) that we have to refer even to the original principles from which our practice is derived, and still less to questions connected with the organization and natural history of timber trees.

The architect, in fact, has seldom any connexion with the choice or conversion of his timber beyond certain limits. His choice is restricted to such qualities of timber of such lengths and scantlings as he can find in *the market*, and on this point less information has perhaps been placed in the hands of the architect, than on any other connected with the subject.

It has been thought, therefore, that a few words on the qualities of timber to be found in the market, as imported from the Baltic and from America, might not be unacceptable to the meeting.

We will begin with European timber in the log, then proceed to American timber, and afterwards to the subject of deals.

Prussia—Memel.—The largest supply of square fir timber brought from any port of the Baltic to this country at the present time is from Memel. It is divided into three qualities,—the best, termed *crown*,—the *best middling*,—and second, or *brack* Memel.

Of the first quality (crown) little comes to the London market, but a considerable quantity to the out-ports. It is of admirable quality and manufacture, nearly as clear of knots as the Riga timber, but not quite so close in the grain, nor so rigid, nor as durable; the more free it is from knots, the more liable it is to be shaky at the core. The knotty timber is less liable to this defect at the heart, because the knots serve as bolts through the timber to keep all the parts together.

Crown Memel timber is usually somewhat more than 13 inches square, and the best of it is from 28 to 55 feet long, that which is longer being usually knotty at the upper extremity. The *best middling* is the highest quality of Memel timber, commonly imported into London; much, likewise, of the *second middling* or *brack* timber comes to the London market.

The chief defect of this quality of timber is, that it contains large knots, which renders it unfit to be cut into small scantlings.

Prussia—Dantzig.—Whenever squared fir timber of great length and size, coupled with durability, is required, the Dantzic timber is to be employed. On the average, Dantzic timber is the longest and largest fir timber that comes here from any port in the Baltic. It may be procured upon order, as much as 70 feet long, and 16 inches square; it commonly runs 14 and 15 inches square.

The cheaper sort or brack timber has the defect of being full of large knots;—the best middling is knotty in a moderate degree, but the crown polish-squared Dantzic timber, that which has been squared in the province where it was felled, may be considered upon the whole the very best timber that the north of Europe supplies: next to that of Riga, it is the most durable of fir timber.

Pillau, Konigsberg, Stretten.—The timber from Pillau, Konigsberg, and Stretten, resembles that of Dantzic, but is rather coarse in the grain, and more knotty; that of Stretten, though not very long, is sometimes of very large size, as much as 20 inches square.

Russia—Riga.—Riga used formerly to be the port from whence almost all the fir timber in the log from 12 to 13 inches square required in this country for building purposes was imported. As timber in the log, it is peculiarly applicable for beams, girders, and joists, being very rigid, and bending little under great weights; it is moreover very regularly squared, very straight, clear of knots, straight in the grain, and very durable.

Owing to its rigidity and freedom from knots, it is however more liable than some other timber to the defect of being rent and shaken at the heart, for which reason the fir timber from other ports on the eastern coast of the Baltic is by many preferred for building purposes, and less of this species of timber is consequently now imported into this country.

Formerly a considerable quantity of timber in the log was imported from Narva, St. Petersburg, and Archangel, but scarcely any now comes from the ports; the Petersburg timber is defective, as being very subject to rend itself and become shaky as it dries.

Norway.—But little timber, and that of small scantling, is now supplied from Norway, although at one time large quantities were imported from Longsound, Porsground, and Brewick; but owing to the change in the mode of taking the duty some years since, by which the small timber of Norway was made liable to the same duty as the large timber from the Baltic (an exception being made only in favour of timber used in the Cornish mines), the importation of timber from that country almost ceased; it is now, however, again making its appearance in the London market.

Some of the superior Longsound timber is of excellent quality, and is perhaps the most durable of fir timber.

Sweden.—The timber from Gottenburgh, Stockholm, and Geffle, is not usually well squared, seldom exceeds 30 feet in length, indeed, is generally much shorter, and has moreover the bad property of rending and becoming shaky if kept in the state of the log, so that unless immediately converted, it loses much of its value; very little, however, of this timber is now imported into England.

American Timber.—The only descriptions of American timber known in the London market, in the state of the log, are the *red pine* and the *yellow pine*, for although the *pitch pine* has been brought here *via* Halifax from the southern ports of the United States, yet that species of fir timber is scarcely known as an article of consumption. It is said to be extremely brittle.

The red pine approaches very nearly in quality the Riga timber; it is almost as stiff, and is free from knots, but the irregular manufacture and tapering of the logs occasions much loss in the conversion for use in buildings: the manufacture of this timber is however improving, and rising in public estimation.

It is the production of Upper Canada and the adjacent portions of the United States; it is brought down from the Great Lakes, on the borders of which it grows, by the river St. Lawrence, in rafts, to Quebec, where it is shipped for England.

Great caution is necessary in the use of this timber. If the voyage from Quebec was as short as that from Riga, it would not perhaps be more liable than Riga timber to take the dry rot; but owing to the length of time that it remains in the ship, or owing to the yellow pine wood, which, as deals or timber, is generally in the same hold with it, a cargo of red pine seldom arrives which does not exhibit on some part or other of the surface of some of the logs indications of the presence of dry rot; and therefore, although the timber, if not so treated, might not be liable to this defect, yet treated as it has been before it arrives here, it often is infected, and if then placed under circumstances only slightly favourable to the growth of the fungus, it will be the means of introducing the dry rot into a building, unless a closer examination be made of the surface of each log to be used than is usually done, or some means adopted to counteract the infection.

Yellow Pine.—The yellow pine timber in the log comes from Quebec, from St. John's, from Miramichi, and from some of the ports of New Brunswick; that from Quebec is not so fit for the better purposes to which yellow pine is applied as that of St. John's, nor is that of St. John's so fit for those purposes as that of Miramichi.

The timber of Miramichi is the lightest and most spongy, and the least fibrous of all; it is exceedingly mellow (to use the joiners' term), has no tendency to warp, and preserves the form given to it by the workman.

Yellow pine timber ought not to be used for rafters, plates, joists, or girders, in any building; indeed for no purpose, or in any situation, where strength and stiffness are required, and where the ends, or any part of the timber, comes in contact with brickwork or masonry, or is subjected to damp.

Yellow pine timber is not rigid, is deficient in strength, will break with a less weight than almost any other kind of timber, and except in perfectly dry situations, or where it is thoroughly ventilated, is extremely liable to take the dry-rot.

We may now proceed to the consideration of timber as *deals, planks*, and *battens*.

The first thing to be considered as regards deals, is the quality of the wood: many deals are of durable quality, and fit on that account for rough out-of-door purposes, and coarse floors or carpentry, that are wholly inapplicable for fine joiners' work, for when the saw has passed through them, and reduced them to small dimensions, they warp and twist like a piece of whalebone. Deals of this kind are termed by carpenters "strong." Such deals have likewise the bad property in general of rending themselves to pieces as they dry, and become shaky.

Deals that, when acted upon by the saw, do not form saw-dust, but are torn into long strips or fibres, and on that account are termed "stringy," are mostly of this strong nature. Such deals are likewise less uniform in their texture, and vary more in the alternate fibres and cellular parts than the deals which are fit for the joiner.

The deal to be good should have a certain degree of softness, easily yielding to the knife or chisel. Such deals are to be distinguished by their light weight in comparison with the strong fibrous deals, and when planed they exhibit a silky texture. Some deals, and particularly the stringy deals, are very hygrometric, and never lose the property (however

long they may have been seasoned,) of expanding and contracting with change of weather. White Petersburg deals are said to possess this property in a peculiar degree. The deal to be good should be straight in the grain; if cross-grained it generally becomes shaken diagonally upon drying, and falls to pieces under the saw; or, if cross-grained in a lesser degree, in does not yield a smooth surface to the plane, but remains rough and fuzzy. The deal should be without coarse knots, and the more nearly it is perfectly clean the better.

As to the manufacture of the deal, it should be square cut, and above all things, it ought *not* to have the centre or pith of the tree left within it, since when that is the case the deal rends on drying.

In yellow deals the sap, or alburnum of the tree, ought to show itself only at the very edge of that part of the deal which was furthest from the centre of the tree.

Deals are usually cut of three different widths, each of which has its appropriate name. Those from 11 to 12 inches wide are called "planks;" those from 8½ to 10 inches, "deals;" and those from 6½ to 7 inches, "battens."

We shall now proceed to the different descriptions of deals.

Norway Deals.—The yellow deals of Christiania in Norway have always been considered to be of the very best description; they are so in two senses: they are both durable and mellow (*mellow* meaning soft, light, and fit for the joiner); though soft, they are not wanting in a proper degree of stiffness: when properly seasoned previously to being used, they remain (however minutely divided) precisely of the form that the joiner gives.

This quality applies to the white as well as to the yellow deals of Christiania, and to them above the deals of any other part of the world, and therefore the deals of Christiania will always be the material that the consumer will endeavour to obtain, if the price will enable him to do so. Of late years, the mode of taking the duty caused the deals to be cut in longer lengths than the timber would properly afford, so that inferior wood was brought into the London market, and the high estimation and price diminished in a certain extent. It is said, however, that they are now rapidly regaining their former character.

Frederickstadt.—The yellow deals from Frederickstadt in Norway are very nearly the same quality with those of Christiania, and generally obtain about the same price in the market.

The white deals would be as good as those of Christiania, but for one defect, which is, that the bark of the tree adheres to the knots, which have therefore a black ring round them. When the deal comes to be cut into board, a knot of this kind is apt to fall out.

It may be noticed, that neither the deals of Christiania or Frederickstadt are of as good a quality as they used to be, particularly as respects the yellow deals.

There are several kinds of yellow deal not quite so good as those of Christiania in the quality of the wood, and yet coming very near to them, which used formerly to be imported from Norway in very large quantities, and still are imported from some of the places of shipment referred to, but to a moderate extent only. The principal of these ports are Longsound, Porsground, Larwig, Krageroe, and Dram. The cloister deals from Longsound, and the broad and clean deals from Krageroe, 1¼ in. thick and 14 feet long, were noted for their excellence.

From Drum an immense quantity both of white and yellow deals were imported, usually 10 feet long and 2 inches thick. The "lowland" deals from this port are of an inferior quality, but the "upland" of superior.

Of the deals of most of the above-mentioned ports it may be said, that they are good as regards the texture of the wood, but small in size, as they are seldom more than from 8½ to 8¾ inches wide.

Some few deals (principally white deals) used to come from Tonsberg, and occasionally there was a considerable supply from Frederickshall and Moss, the yellow deals of which ports are of bad quality, and the white deals not much better.

Of the white lowland deals of Norway in general it may be said, that they resemble in quality the white spruce deals of America; they have the same tendency to warp and to rend in drying.

Sweden.—The yellow deals of Sweden, nearest in quality to the best yellow deals of Norway, as regards their being at the same time durable and mellow, are those which come from Stockholm and Geffle, in the Gulf of Bothnia. If Stockholm or Geffle deals were quite as mellow as Christiania deals, they would be preferred to them on account of their full size and freedom from sap, but they are somewhat more disposed to warp, and as respects the Geffle deals, to have coarse knots.

There are some other parts of the Gulph of Bothnia, viz:—Hernosand and Sundswall, from which cargoes of yellow deals are occasionally shipped, little inferior to those of Stockholm and Geffle; but it may be said of most of the deals from those ports, that there is in general an exaggeration of the faults visible in the deals of Stockholm and Geffle. A large portion of the deals from Hernosand and Sundswall are from 16 to 20 feet long and 10 inches wide.

The deals of Soderham and Schouwick are of a still harder and coarser nature, and the yellow deals of Gottenburgh, although very free from sap, and durable, yet have the fault of being rigid and unfit for the joiner: they are, however, well adapted for rough purposes, both in and out of doors, on account of their durability.

Deals of Northern Russia.—The yellow deals of Archangel and Onega are very similar to each other in quality, and of all deals they approach in one respect the nearest to the yellow deals of Christiania; they are exceedingly mellow, and fit for the joiner: on the other hand they are not very durable or capable of resisting damp, for which reason they ought not to be used in the ground floor of a house; the knots are apt to be surrounded with dead bark: they are imported of the average length of 20 feet.

Archangel deals formerly were imported only of the width of 11 inches, or 7 inches, that is, in the state of plank or of battens, but more recently they have been imported of the width of 9 inches, and from the certainty of obtaining entire cargoes of the very first quality without any admixture of inferior goods (an object which could seldom be accomplished with regard either to Norwegian or Swedish deals), this description of deals were made to supersede the use of almost every other superior kind of European deal.

St. Petersburg and Narva yellow deals come of the breadth of 11, 9, and 7 inches: in quality the wood is inferior to that of Onega or of Archangel.

Petersburg deal is less durable and not nearly so mellow as either the Archangel or Onega deal: it is said to be nearly as liable to take the dry rot, in a damp and confined situation, as the yellow pine deal of America.

A very few deals are imported from Riga.

The yellow deals from Memel and Dantzic may be next noticed, the former 11 inches, the latter 12 inches wide; both of these are very durable. Memel planks are well adapted for all rough purposes of doors,—for barn floors, and when clean, for the steps of stairs.

Dantzic planks are much used for making the large vessels used by brewers, called backs. The very best of the Dantzic planks are likewise extremely fit for joiners' work, as they are soft and mellow, and retain the shape; this, however, applies to but a small portion of them, and those which are so soft are not so durable.

Dantzic affords, likewise, the long yellow plank, 40 feet long, 3 inches thick, and 12 inches wide, used for the decks of ships.

Memel plank until of late was not imported in any large quantity.

There are, likewise, yellow deals from Finland. Nyland deals, 14 feet long, resembling some of the coarser varieties of Sundswall deals, are of late introduction.

The broad yellow planks, 12 inches wide, and 21 feet long, from Biorneberg, in the Gulph of Bothnia, are of a quality very nearly approaching to the plank of Archangel, but far more knotty.

White Deals.—We now come to the white deals, manufactured from the *Spruce Fir;* the yellow deals of Europe being manufactured from the *Scotch Fir.*

All that has been said of the qualities of yellow deals applies likewise to white deals, except that the sap in white deals is not discernable from the heart, and therefore the manufacturer of white deals has so far one difficulty the less to contend with.

Norway is the only country from which white deals of the very first quality are imported in any considerable quality, for although the white deals of Stockholm and Geffle in Sweden, like the yellow from those parts, are very good, yet the quantity supplied is too small to render them worthy of particular notice.

The white deals, like the yellow, shipped at Christiania, are the very best in the world,—fit for joiners' work, and above all other deals of the kind, light and mellow.

The white deals of Frederickstadt also are very good, yet rather subject to a small black knot, surrounded by dead bark.

All the other ports in Norway, which have been mentioned as yielding yellow deals, supply white deals of good quality likewise; but from the smaller ports generally, the deals are rather narrow (from 8½ to 8¾ wide), whereas the deals from Christiania and Frederickstadt are full 9 inches wide. The narrow deals fetch a proportionably less price in the market.

The white deals from Wikkeroe are sold under the name of Christiania deals, the least mellow and the hardest of which they resemble: they are of greater average length than the deals of Christiania, being perhaps of a mean length of 19 feet.

The lowland white deals of Norway form the exception to the general good quality of the white deals of that country; the lowland white deals having most of the bad properties of the white spruce of America, namely, a tendency to warp and to split in drying.

From Dram two qualities of white deals used to come, the "upland" and the "lowland," the former as *good* in quality as the latter *bad;* of late years however they have considerably improved.

The white deals of Moss, though showy to appearance, are of this bad quality: those from Longsound, Schien, and Larwig, are good.

A considerable quantity of white deals have of late years been shipped from Gottenburg: they are, with occasional exceptions, of a hard, stringy nature; the saw, on passing through them, tears their substance into strings instead of saw-dust. The white deals, 11 and 12 inches wide, from this port are, on account of their cheapness, one of the materials much used by the makers of packing cases.

Northern Russia.—Northern Russia exports hardly any white deals, although the few that occasionally come from Archangel, mixed by accident with yellow deals, are of excellent quality. The white deals from that country that come nearest to those of Norway in quality, are from Narva; they are brought of the width of 11 and 9 inches: when properly seasoned they can be used for all purposes to which Norway white deals are applied. Next in quality to those of Narva are the white deals from Riga, which are brought both 9 and 11 inches wide.

White deals are imported from St. Petersburg both 9 and 11 inches wide, in considerable quantities; they are not uniform in texture, but contain hard veins, and they have the defect, however long they may have been kept, of expanding and contracting with change of weather; so that if used in the panel of a door, the wood alternately enters and recedes from the groove into which it fits, as the paint will show when that kind of deal has been used for a panel.

Battens are deals 7 inches wide, and are principally used for floors: the best yellow battens are imported from Christiania: a large number both of white and yellow battens were formerly imported from Longsound, in Norway, but they now chiefly come from Dram; they are from 6¼ to 6¾ wide. The white especially are of an excellent quality, and so are such of the yellow as are not sappy: the sappy ones preponderate in number, and on account of their cheapness are frequently used as a substitute for timber in building the smaller description of houses.

The next in quality to the battens of Christiania and Frederickstadt are those which are imported from Archangel and Onega, though few have of late come from the latter port. Yellow Archangel battens cost usually somewhat more by the St. Petersburg standard than the 11-inch planks. Both Archangel and Onega battens have the defect of having black bark round the knots, the wood of which is dead, whereas the knots of Christiania wood are bright, and firmly united to the substance of the tree. Yellow battens are likewise imported from St. Petersburg; they are considerably inferior in the quality of the wood to those of Archangel and Onega.

American deals are of three descriptions, viz:—the yellow pine, the red pine, and the white spruce. A fourth, the hemlock spruce deal, is sometimes brought here, but it is too bad in quality, and the quantity ever in the market too small, to deserve further notice.

The best of the yellow pine deals are shipped from the St. Lawrence; some are floated down the river from the mills to the port of shipment, and when taken on board are saturated with water and covered with river silt; others are put on board craft, and come bright from the saw to this country.

Of the bright deals, the very best in quality are those from the Riviere de Loup.

In a very good parcel of yellow pine deals about ⅝ will be perfectly clear of knots.

Yellow pine is of a light and spongy texture, and the more completely it is of that texture, and the opposite of what is hard, fibrous, and stringy, the better it is for all the purposes to which it is properly applicable, such as panels and mouldings of doors and shutters, panels of framing, and other internal fittings of houses; the frame of cabinet work; all those purposes in short for which *lightness* and no great strength is required.

It preserves the form which the joiner gives it without warping, and this property, coupled with the facility with which it is obtained free from knots, fits it admirably for the carver, the musical instrument maker, the maker of Venetian blinds, for patterns for iron castings and similar purposes. The inferior yellow pine deals, being coarser in the texture of the wood and more knotty, are mostly used for packing cases.

If the yellow pine be exposed to damp in any confined situation, it decays rapidly; but in the open air, for palings raised from off the ground, weather boarding for sheds, and wherever it is completely ventilated, it will last a long time, although exposed to alternations of wet and dry. Its spongy texture prevents its being rent, so much as deals of a more rigid substance are liable to be, by exposure to the weather; it is now much used for decks of ships, as it resists the effects of the sun better than the European deals.

Red pine deals come in very small quantities, so small indeed that they are seldom separated from the yellow pine deals with which they come mixed; the best description are such as are brought from the Riviere de Loup.

The red pine deal will answer for most of the purposes to which the yellow or Scotch fir deal of Europe is applied: when used for floors in houses it has the defect of turning to a very dark colour, but this is probably owing to its resinous texture, which causes dust to adhere to its surface, and might be prevented by washing the surface with alkaline ley or any other solvent of resin.

Of the American white spruce deals none, not even the very best, are to be compared for quality with the white deals of the North of Europe—they have two faults; they are very subject to warp, and the knots in them (owing to the bark adhering to the branch while the wood grows over it,) are liable to fall out and leave a hole in the board. However long deals of this kind may be kept, they never lose their property of *warping*, and are consequently totally unfit for joiners' work, and are for the most part used for floors in houses of the lower description. If placed in damp situations they are very liable to decay. An instance of this is mentioned by Mr. Warburton (in his Evidence before the Select Committee on the Timber Duties, in 1835), as having occurred in the floor of his counting-house at Lambeth, which he had caused to be made of white spruce deals, as the cheapest material. An unusually high tide in the river Thames laid the floor under water, which at the time was covered with oil-cloth, which *being replaced upon it before it was thoroughly dry*, in less than a week the dry rot had spread over the whole floor, and had penetrated in some parts below the surface of the deal.

This, however, must be acknowledged was a most severe test, and indeed it may be fairly doubted whether the result would have been very different with any deals of any country. It should, however, operate as a caution to us against covering the floors of basement stories, in particular, with oil-cloth,—a practice which (though becoming more frequent every day,) is always attended with the most injurious effect to the floor.

Of this species the white spruce deal, as well as of every other description of American deal, and especially of the yellow pine deal, it may be observed, that they ought only to be used in situations that are perfectly dry, or if not dry, that are completely exposed to the air.

It is stated that every deal of yellow pine that has been shipped in America in a wet state, when it arrives here is covered over by a network of small white fibres, which are the dry-rot in an incipient state. There is no cargo, even if shipped in tolerably dry condition, in which, upon its arrival, some deals will not be found with the fungus beginning to vegetate on their surfaces. If they are deals that have been floated down the rivers in America, and shipped in a wet state, they arrive quite covered with this net-work of fungus, so that force is necessary to separate one deal from another, so strongly does the fungus occasion them to adhere. They will grow together again, as it were, after quitting the ship, whilst lying in the barges previously to being landed: accordingly, if a large cargo has arrived in a wet condition, or late in the year, or if the rain fall on the deals before they are landed, and they are piled flat, one on the other (after the usual manner of piling deals), in six months time, or even less, the whole pile of deals will become deeply affected by the dry-rot, so that wherever the flat surface of one deal lies upon the flat surface of another, the rot penetrates to the depth perhaps of the 8th of an inch. Its progress is arrested, frequently, by re-piling the deals during the dry weather of the month of March, and by sweeping the surface of each deal, before it is re-piled, with a hard broom; but perhaps the best way is to pile the deals, in the first instance, upon their edges, by which means the air circulates round them, the growth of the fungus is checked, and the necessity of re-piling them avoided.

As respects the dry-rot it may be noticed, that there are but very few cargoes of timber in the log that come from America, in which, in one part or other of every log, a beginning of the vegetation of the dry-rot is not apparent. Sometimes it will show itself only by a few reddish, discoloured spots on the surface of the log, which if scratched with the nail will show, that to the extent of each spot, the texture of the timber to some little depth is destroyed,—it will be reduced to powder. A white fibre will generally be seen growing on these spots.

If the timber has been shipped in dry condition, and the voyage has been a short one, there may be some logs without a spot; but if the cargo has been shipped in a wet condition, and the voyage has been long, then a white fibre will be seen growing over every part of the surface of every log.

It should further be noticed in connection with this subject, that there are likewise two descriptions of European timber very liable to take the dry-rot,—yellow Petersburg deals, and yellow and white battens from Dram in Norway. Battens that have been received from Dram, and allowed to be a long time in bond in this country, without being re-piled in time, as they ought to have been, have been as much affected by the dry-rot as many American deals, though this had not happened in as short a time as has been known to be sufficient to rot American deals. That the fungus growing on the surface of American timber is the dry-rot, appears to be quite certain; it has all its character as to appearance and as to effect, for whenever it spreads over the surface, the deal, if neglected, is reduced to the state of powder.

These, Gentlemen, are a few leading facts connected with the important subject of the selection of such timber as is placed within our reach, and to which for the most part our choice is limited. For a mass of information on every thing connected with the subject, we may refer to the

documents from which these few particulars have been chiefly gathered, —the Parliamentary Reports and Evidence on the Timber Duties; and in conclusion we must add, that the present paper has been materially founded on the abstracts made from the Report of 1835, kindly placed in our hands by Professor Donaldson.

ON FLAT ROOFS COVERED WITH CLAY AND OTHER SUBSTANCES.

(Continued from p. 322.)

"The surface of these roofs soon attains consistence enough to bear the foot-step without damage, and it is then time to apply the outer coat. This may, however, be delayed till the composition becomes hard enough to bear a smart blow with a hammer. Should too rapid a drying have occasioned cracks, they must be carefully filled with sand before covering the whole with the impermeable outer covering. The roof alluded to above remained a whole winter before receiving the last coat, and was perfectly tight. This might be deemed a sufficient warrant for the universal application of this method; but there is some fear lest this mastic, exposed above and below to the action of the air, may not become so stiff as to crack, either spontaneously, or by some trifling accident: experience alone can satisfy us upon this point.

"This mastic is applied much in the same manner as the preceding, but it is rather more expensive, owing to the greater price of charcoal.

"The *Coal-ash Mastic* was first used with success in 1836 for roofing a gas manufactory at Berlin, and has since been repeated in many new constructions in that city. It is composed of coal tar and coal ashes, and is prepared in the same manner as the charcoal mastic, in the proportion of 4½ quarts of the coal tar to a cube foot of the ashes, by which a mass is formed not over liquid, and which spreads with facility upon the lathing, like common cement. This mastic is of course much less expensive than that made with charcoal, especially in a gas establishment; but the latter is more elastic, and appears less liable to that great degree of desiccation which renders it stiff and liable to crack.

"The slope of the roof, &c., may be the same as with the other mastics, but the lathing must be closer together, on account of the greater liability of this mastic to crumble into pieces. The mode of applying it is also the same; it may be levelled in the same manner, either with a rammer or a roller, and it should be covered with dry charcoal ashes to prevent these instruments from sticking to it.

"On account of the slight degree of elasticity possessed by this mastic when thoroughly dry, the least settlement in the carpentry of the roof, or in the lathing, will produce small cracks, which can indeed be filled with ashes and tar, but which are apt to enlarge till they cannot be very easily remedied. This has given rise to the idea of putting on a coat of the clay mixture first; which, being only ⅜ to ½ an inch thick, will dry quickly, so that it may soon be saturated with boiling tar, and then receive over it the coat of mastic. This plan could only be carried into effect in very fine and hot weather; but when executed under favourable conditions, a roof thus formed appears to offer every probability of long duration.

"These different mastics are of more certain utility for the recovering of massive constructions of masonry, terraces, vaults, &c., always taking care that the works are completely dry before it is applied. In such a case, and on a firm foundation, cracks and crevices are of much less consequence than upon a lathwork more or less elastic."

NEW CHURCH AT SOUTHAMPTON.

The new church now erecting in the parish of All Saints, Southampton, from the designs of O. W. Carter, Esq., the first stone of which was laid on the 19th August, is to be in the Norman style, and will have a chancel 28ft. by 23ft. 6in., and a nave 73ft. by 32, with a south porch, and a tower at the north-west angle. The walls are to be of stone throughout. The west front will consist of a rather large and handsome Norman door in the centre of the lower division, a triplet of round-headed windows above, and a circular window, in some degree similar to that in Castle Hedingham church, Essex, in the gable. The tower will be of three stages, the lower having a door, and the two upper handsome Norman windows, of two lights each, lighting the belfry and bell chamber; the one with two columns engaged on each side and one in the centre detached, and the other with three columns on each side. Instead of a spire, the tower will have a roof similar to those common in German churches, and of which we have an instance in Sompting church, Sussex. Each of its gables will have a semicircular-headed window, and the quadrangular, spire-like roof will be covered with tiles.

There will be a good Norman door in the porch. The side elevation will consist of six bays divided by buttresses, which run up and meet a corbel table of semicircular arches, supporting the stone eaves gutter. There will be three windows on each side,—one in every other bay,—of simple character, with good internal splay. The chancel is apsidal, and has three windows. The corbel table under the eaves is of rather different character to that in the body of the church, and more handsome. The interior is divided (as are almost all old Norman churches of any size or pretensions) into three parts by two semicircular arches, one in front of the chancel, and the other west of it. Between these it is in contemplation, at some future time when the funds will admit of it, to throw out transepts, for which provision is now to be made in the roof and walls. The roof, which is of as high pitch as the character of a Norman building allows, will be open to the ridge, and will not have a tie-beam. The common rafters will all be shown, as will all the timbers. The majority of the sittings will be open and free. The seats have low, square ends, adapted from some in the neighbourhood of Winchester, of very early date. The pews are similar, and it is hoped that the doors with which they are intended to be furnished may be dispensed with, as it would much improve the effect of the church. The material of the walls of the church is Swanage stone, and the dressings, &c. are of Caen stone. Great care will be taken in the bond of the masonry, to follow old authorities, very much of the effect of the church depending upon this point, which has been too generally neglected in modern imitations of old work.

There will be a small gallery at the west end of the church. The necessity for this is to be regretted, but it has been rendered as unobtrusive as possible, and it is to be hoped that (if it is erected) at some future time it may be taken down.

It is hoped that the funds will admit of at least the three east windows being filled with stained glass, as it will very materially enhance the effect.

The church will be tiled throughout: the ridge tiles will be ornamental, and from ancient authorities.

The design is throughout in excellent keeping, and exceedingly creditable to Mr. Carter's knowledge as an architectural antiquary, and his taste as an artist. We have seen more than one Gothic design by this gentleman, of which the same might with great justice be said.

This church is intended to accommodate 520 persons, and will cost £2960.

SPECIFICATION OF THE WORKS REQUIRED TO BE EXECUTED FOR THE SOUTHEND PIER COMPANY,

IN CONSTRUCTING A NEW PIER HEAD, AND EXTENDING THE PRESENT PIER, AGREEABLY WITH THE ACCOMPANYING DRAWINGS, MARKED "SOUTHEND PIER, W. D.," NO. 1 TO 10 INCLUSIVE, AND SIGNED JAMES SIMPSON, CIVIL ENGINEER.

GENERAL DESCRIPTION, AND CONSTRUCTION OF WORKS.

THE works in this specification comprise all the labour, tools, implements, materials, carriages and other things requisite to remove the piles, platforms, stairs, and other works in the present pier head and lighthouse platform, and to construct and complete the new pier head and extension of the present pier, including platforms, resting-places, landing-places, and stairs in connection therewith, as shown in the drawings above enumerated. The present lighthouse is to be carefully removed and deposited on the shore, with a view to its re-erection on the new pier head.

The pier is to be constructed partly with cast-iron piles and partly with timber piles, to which the platforms, resting-places, landing-places, and stairs are to be fixed.

Datum Line.—The top of the floor or platform of the pier head, and the top of the floor of the gangway or road of the extension of the pier, are to be level throughout, the datum line of such level being 12 inches above the upper surface or floor at the face or termination of the platform of the present pier.

Pier Head.—The whole of the piles and timber connected with the present pier head or lighthouse platform is to be constructed with 40 timber piles, resting in and fixed to 40 cast-iron piles, and to be protected by 18 fender piles, finished with heads for mooring ropes, and a fender piece in front of each.

The lower platform of the pier head is to be constructed with planks supported on beams secured to the piles, and finished with railing and one flight of stairs and rails to communicate with the middle platform, as shown on drawings Nos. 8, 9, and 10.

The middle platform is to extend entirely round and across the pier head, and to be constructed with planks supported on beams secured to the piles, and finished with railing and two flights of stairs and rails to communicate with the upper platform, as shown on drawings Nos. 7, 9, and 10.

The upper platform is to extend over the entire pier head, having two openings for the stairs to the middle platform. It is to be constructed of planks supported on beams secured to the piles, and finished with railing, as shown on drawings Nos. 6, 9, and 10.

Centre Line.—The centre line of the platform of the gangway or road is to be straight, and direct from the centre of the present lighthouse platform to the centre of the termination or face of the present pier.

Gangway or Road.—The first bay, or No. 1, a length of 20 feet of the floor of the gangway or road from the pier head northwards, is to commence 12 feet 9 inches wide, and finish 8 feet 9 inches wide, with 4 fender piles and waling, as shown on drawings Nos. 3, 6, and 10.

The next 34 piles of 28 feet each, that is, from No. 2 to 35 inclusive, or a length of 952 feet or thereabouts of the floor of the gangway or road, is to be 8 feet 9 inches wide, as shown on drawing No. 3.

The next, or 36th bay, or a length of 16 feet 10 inches, is to be a resting place, with the floor of its platform, including the gangway or roadway, 18 feet 5 inches wide, as shown on drawing No. 4.

Gangway or Road.—The next 35 bays, of 28 feet each, that is, from Nos. 37 to 71 inclusive, or a length of 980 feet or thereabouts of the floor of the gangway or road, is to be 8 feet 9 inches wide, as shown on drawing No. 3.

Resting Place.—The next, or 72nd bay, or a length of 16 feet 10½ inches, is to be a resting place, with the floor of its platform, including the gangway or road, 18 feet 5 inches wide, as shown on drawing No. 4.

Gangway or Road.—The next 17 bays of 28 feet each, that is, from No. 73 to 89 inclusive, or a length of 476 feet or thereabouts of the floor of the gangway or road, is to be 8 feet 9 inches wide, as shown in drawing No. 3.

Central Landing Place.—The next 4 bays of 14 feet each, that is, from Nos. 90 to 93 inclusive, or a length of 56 feet, is to be a landing place, with the floor of the platform, including the gangway or road, 20 feet 6 inches wide, with fender piles, stairs, and railing, as shown on drawing No. 5.

Gangway or Road.—The next 17 bays of 28 feet each, that is, from Nos. 94 to 110 inclusive, or a length of 476 feet or thereabouts of the floor of the gangway or road, is to be 8 feet 9 inches wide, as shown on drawing No. 3.

Resting Place.—The next, or 111th bay, or a length of 16 feet 10½ inches, is to be a resting place, with the floor of its platform, including the gangway or road, 18 feet 5 inches wide, as shown on drawing No. 4.

Gangway or Road.—The next 35 bays of 28 feet each, that is, from Nos. 112 to 146 inclusive, or a length of 980 feet or thereabouts of the floor of the gangway or road, is to be 8 feet 9 inches wide, as shown on drawing No. 3, with the exception of the cast-iron piles.

Resting Place.—The next, or 147th bay, or a length of 16 feet 10½ inches, is to be a resting place, with the floor of its platform, including the gangway or road, 18 feet 5 inches wide, as shown on drawing No. 4, with the exception of the cast-iron piles.

Gangway or Road.—The next 30 bays of 28 feet each, that is, from Nos. 148 to 177 inclusive, or a length of 840 feet or thereabouts of the floor of the gangway or road, is to be 8 feet 9 inches wide, as shown on drawing No. 3, with the exception of the cast-iron piles.

The before-mentioned 111 bays, Nos. 1 to 111 inclusive from the pier head, are to be constructed with 242 timber piles, resting in and fixed to 242 cast-iron piles, with 2 cast-iron fitted keys to each. The next 66 bays, that is, from Nos. 112 to 177 inclusive, are to be constructed with 136 timber piles, shod with iron.

The whole of the piles of the bays are to be secured with cross-braces, as shown on drawings Nos. 3, 4, and 5, and the entire length of the gangway or road is to be formed of planks fixed to the longitudinal beams, which are to be supported on sills and templet caps, secured to the pile heads with wrought-iron straps, keys, bolts, nuts, and plates, and the whole is to be finished on each side with permanent railing.

Cast-iron Piles.—The cast-iron piles are to be square outside and inside, as shown on drawing No. 2, the thickness of the metal being uniform, except where otherwise shown, with a projecting band at top; at the depth of 5 feet 1 inch from the top inside of the piles, there is to be a flange seat projecting from the inner surface, to sustain the driving plates, and the bottoms of the piles are to be cast with cutting edges; each pile is to have two key-ways, and to be fitted with two cast-iron keys and a driving-plate; part of the piles are to be cast with double and part with single brackets, as shown on drawing No. 2.

Fir Timber Piles.—All the iron piles are to be lowered, set, and driven with punching timbers, to prevent the necessity of using the permanent timber piles for that purpose; the 282 timber piles which are to be fixed to the iron piles to form the pier head, and the 111 outer bays of the pier, are to be of fir; the lower ends of the timber for a length of 5 feet are to be wrought and fitted into the cast-iron piles, the ends squared to bear equally on the driving piles, and previously to be driven in; the timber is to be charred and tarred; the space within the piles above the shore is to be filled with concrete, and the inside of the heads of the iron piles cleaned out and perfectly dried; after the timber piles are driven into the cast-iron piles, the mortices are to be cut, and the cast-iron piles driven in and rivetted.

Oak Timber Piles.—The 136 timber piles before mentioned are to be of oak, and each shod with a wrought-iron shoe, and driven to a depth varying from 8 feet to 8 feet 6 inches into the ground or shore.

Fender Piles.—The fender piles, 34 in number, are to be of fir, and each driven with a wrought-iron shoe to a a depth of from 9 to 10 feet into the ground or shoe, being previously to driving hooped, charred, tarred, and scupper-nailed over the entire surface, from the level of the top of the cast-iron piles to the depth of at least 3 feet

below the surface of the ground or shore. The fender pieces are to be of oak, securely fastened to the fender piles with jagged spikes.

Braces, Sills, &c.—The braces, sills, chocks, cleats, templet caps and keys for scarfs are to be of oak, and secured to the main piles with wrought-iron straps and spikes, keys, bolts, nuts, and plates, as shown on drawings Nos. 3, 4, 5, 6, 7, 8, 9, and 10.

Longitudinal Beams.—The longitudinal beams are to be of fir, the outer sides of the chain beams to be wrought and planed, and to be in as long lengths as possible, and where necessary, they are to be scarfed together in the manner shown on drawing No. 3, and fixed in such a way that no two scarfs or joinings of the outside main beams shall be directly opposite to each other.

Flooring and Platforms.—The flooring and platforms are to consist of parallel oak planks laid with spaces of half an inch between them, securely spiked to the longitudinal beams, and to be wrought and planed on the upper side, and left with a fair and even surface.

Stairs.—The stairs for the pier head and landing places are to be of oak, the strings fastened together and secured to the piles with wrought-iron straps and bolts, as shown on drawings Nos. 5, 6, 7, 9, and 10.

Railing.—The railing is to consist of oak posts, secured to the longitudinal beams with wrought-iron straps, bolts, nuts, and plates, and three fir horizontal rails, the whole to be wrought and planed, the pannels being filled up with vertical wrought-iron bars let into the middle and bottom rails; four of the bars in each bay are to be made with collars to rest on the centre rail, and with screwed ends and nuts to secure the top and bottom rails, and the entire railing finished with oak capping, as shown on drawing No. 3.

Painting, &c.—The whole of the wrought-iron straps, keys, plates, bolts, and nuts to be painted four times in oil, and finished a black colour; the under-side of the floor and platforms and the inner longitudinal beams, and the whole of the timber below the level of the top of the diagonal braces, and the iron piles from the level of 5 feet above the driving end, are to be covered with two coats of pitch and tar mixed together in equal quantities; and all joints and scarfs throughout the work, as well as the part of the wooden piles driven into the iron, are to be covered in a similar manner previously to their being put together; the whole of the timber above the level of the top of the diagonal braces that is not pitched and tarred as above, as well as the wrought-iron railing after fixing, is to be painted four times in oil, and finished of such a plain stone colour as may be directed.

Braces and Mooring Posts.—Diagonal braces and additional mooring posts will be required at the pier head and landing place, and these are to be fixed and secured with wrought-iron work in such places and in such manner as the engineer shall direct after the platforms and stairs are completed. All such additional diagonal braces and mooring posts are to be considered as extra works, and paid for according to rates and prices to be stated in a schedule annexed to the tender.

Bed of River.—The levels of the bed of the river and shore being variable, the lines on the drawings which refer to such levels have been delineated from drawings made in November 1842.

Tides.—The levels of spring and neap tides marked on the drawings are from observations made in the months of April and May.

MATERIALS.

Cast Iron.—The iron piles are to be cast in dry sand moulds, and the whole of the cast-iron work to be from cold-blast iron of a good tough quality, and not inferior to No. 2 Pig, second making.

Wrought Iron.—The wrought iron is to be of the best scrap iron, and not inferior to bars.

Fir Timber.—The fir is to be new Memel or Dantzic timber of approved quality, free from sap, shakes, and dead knots, and all other imperfections.

Oak Timber.—The Company has about 500 loads of oak timber lying contiguous to the pier at Southend, which the contractor is to purchase at £5 5*s.* per load, and to use in the work such portions of it as are perfectly sound, and free from sap, shakes, dead knots, and all other imperfections.

Present Lighthouse Platform.—Such of the timber in the present lighthouse platform as is perfectly sound, and free from sap, shakes, and all other imperfections, is to be used in such parts of the work as may be directed by the Company's engineer.

Concrete.—The concrete is to be composed of one part of good fresh-burnt stone lime pounded, and seven parts of clean, sharp, river gravel, mixed with a sufficient quantity of fresh water.

Pitch and Tar.—The pitch is to be the best Swedish pitch, and the tar the best Stockholm tar, and each approved of before mixed.

Paint.—The paint is to be composed of the best white lead and linseed oil, coloured as may be required.

SCANTLINGS AND DIMENSIONS OF CAST-IRON AND WROUGHT-IRON WORK, TIMBER, AND OTHER MATERIALS.

Cast Iron.—The numbers and lengths of the cast-iron piles required are as follows, viz.:—

Pier head,	8 double bracket piles	29	0	long each.
	6 ditto ditto	28	0	—
	6 single ditto	27	6	—
	2 main piles	26	6	—
	8 ditto	26	0	—
	4 ditto	25	6	—
	4 ditto	25	3	—
	2 ditto	25	0	—
No. 1 Bay,	2 main piles	24	6	—
2,	2 ditto	23	6	—
3,	2 ditto	22	6	—
4,	2 ditto	21	6	—
5,	2 ditto	20	3	—
6,	2 ditto	19	0	—
7—14,	16 ditto	18	0	—
15—24,	20 ditto	17	9	—
25—30,	12 ditto	17	6	—
31—34,	7 ditto	17	3	—
35—26,	8 ditto	17	0	—
37—43,	14 ditto	16	6	—
44—50,	14 ditto	16	3	—
51—55,	10 ditto	16	0	—
56—60,	10 ditto	15	6	—
61—65,	10 ditto	15	0	—
66—70,	10 ditto	14	6	—
71—72,	8 ditto	14	0	—
73—77,	10 ditto	13	6	—
78—82,	10 ditto	13	3	—
83—87,	10 ditto	13	3	—
88—101,	36 ditto	12	6	—
102—109,	16 ditto	12	3	—
110—111,	8 ditto	12	3	—

The above piles are to be 13½ inches square outside and 12 inches square inside; the thickness of metal to be ¾ in.; the projecting band around the top to be 3½ in. by ½ in.: the seat for the driving plate to project 1 inch, and the key-ways to be 4 inches by 1 inch.

The 282 cast-iron driving plates for the above piles are to be 12 inches square and 1 inch thick.

The 564 cast-iron keys are to be 4 inches by 1 inch, and 14¾ in. long each.

Wrought Iron.—The straps for the piles are to be 3½ in. by ⅝ in.

The straps for the railing to be 2 in. by ¼ in.

The railing bars to be ⅝ in. diameter and 1 ft. 8 in. long each, let ¾ in. deep into the middle and bottom rails.

The gibs and keys for the pile heads to be 3½ in. by ⅝ in.

The bolts for the piles, braces, and outer templet caps are to be 1 inch in diameter.

The bolts for the pile heads, sills, stairs, and railing to be ¾ in. diameter.

The spikes for fenders and braces to be 9 inches long.

The spikes for railing to be 7 inches long.

The spikes for flooring to be 5 inches long.

The shoes for fender piles not to weigh less than 24 lb. each.

The shoes for oak main piles not to weigh less than 21 lb. each.

Scupper Nails.—The heads to be 1 inch square, shanks 1½ in. long, and not to weigh less than 1 ounce each.

Timber.—Fir piles not to be less than 13½ in. by 13½ in.

Outer beams	„	13½	by	6¾.
Inner ditto	„	13½	„	3½.
Railing bottom rail	„	4	„	3.
„ middle	„	4	„	3.
Fir railing top	„	4	„	2½.
Oak piles	„	12	„	0 diameter at ground level.
Fenders	„	12	„	4.
Diagonal braces	„	8	„	4.
Sills	„	12	„	5.
Outer templet caps	„	9	„	6¾.
Inner ditto	„	9	„	3½.
Flooring planks	„	9	„	2.
Posts to railing	„	5	„	4.
Capping to do.	„	5½	„	1½.

RAILWAY TO HOLYHEAD OR PORT-DYN-LLAEN.

In our last Number we placed before our readers the evidence which has been given by certain engineers and nautical officers, upon the relative facilities offered by Holyhead and Port-dyn-llaen for the establishment of a packet station. It is now our intention to collect the opinions of the Railway Commissioners and Mr. Walker, upon the facilities of forming a line of railway to these harbours, and having placed this information before our readers, we shall probably on a future occasion make a few remarks upon the entire body of evidence. In attempting to form an opinion upon the advantages offered by these two localities for a post-office communication between Great Britain and Ireland, regard must be had to the facilities of communication with the great lines of railway. Any harbour that cannot give perfect security, and is not of easy access, must be rejected as unsuited for a station, but any two or more harbours possessing a capability of affording the required protection to shipping, and facilities for improvement by art, must then be considered in reference to the periods in which they can be made to communicate between the two countries, or rather the metropolis of each, London on the one side, and Dublin on the other. The time occupied in passing from these harbours to the coast of Ireland is not so much a matter of importance as the time required in passing from one city to the other. A rapid and safe communication between England and Ireland is of momentous importance to both countries, and chiefly so to the latter. All private or local interests should therefore be entirely disregarded, and the question be viewed simply as one of national importance.

In November, 1839, Col. Sir Frederick Smith and Professor Barlow were instructed by the Lords of the Treasury, "to inquire and report upon the relative merits, and the preference which ought to be given to the respective and already surveyed and projected railways, following:—namely, from Holyhead, *viâ* Bangor and Chester; Port-dyn-llaen, *viâ* Caernarvon, Bangor, and Chester; Port-dyn-llaen, *viâ* Barmouth, Bala, and Shrewsbury; Orme's Head, *viâ* Chester."

"We have observed," the reporters state, "that for the route by Chester to Holyhead there are two projects; one of which is recommended by Mr. George Stephenson, civil engineer, and the other by Mr. Giles, civil engineer.

"One line only has been proposed to Orme's Head, and this has been brought forward by Mr. Jenkins, civil engineer.

"The three above-named gentlemen submitted to us such plans, sections, and reports of their lines as we considered would be sufficient to enable us to decide on their relative merits, after an examination of the country through which it is proposed that they should pass.

"It appears that Mr. Vignoles and Mr. Rastrick were the civil engineers employed to make surveys of a railway, leading from Port-dyn-llaen towards London, and the former gentleman reported the result of these researches to the Commissioners for the proposed lines of railway in Ireland, which is published in the appendix of their Report. Mr. Vignoles there gives it as his opinion that the best line for a railway from Port-dyn-llaen is by Pwllheli, Tremadoc, Harlech, Barmouth, Dolgelly, Drews-y-nant, Bala, and Shrewsbury.

"He attached to his Report a tracing of this line on a map compiled from the Ordnance Map of North Wales, and he also supplied a detailed section of it from Port-dyn-llaen as far as Bala, but beyond that point there is nothing definite to guide us, as to Mr. Vignoles's project.

"Mr. George Stephenson states, in his printed Report to the Directors of the Chester and Crewe Railway, that he has more recently had the country between Port-dyn-llaen and Bala surveyed, keeping nearly in the tract pointed out by Mr. Vignoles; and of this survey, which Mr. Stephenson extended to Chirk, thirty miles beyond Bala, he has given both a section and a verbal description.

"It appears that a line was surveyed between Wolverhampton and Shrewsbury, on which Mr. Locke has made a report. A copy of this Report was forwarded to us, but we do not learn that any survey has hitherto been made for determining the best line between Shrewsbury and Chirk, so that the project for a railway communication between London and Port-dyn-llaen, by the route recommended by Mr. Vignoles, is apparently still incomplete.

"Of the line from Port-dyn-llaen to Bangor, we were not enabled to procure any plans or sections previously to our commencing the inspection of this part of the country; and until our reaching Chester, where Mr. Henry Archer acquainted us that he is the promoter of this line, we were not aware that it was likely to be supported."

As it is not so much our intention to compare various lines of railway to the same port, as to ascertain which locality admits of the best communication with London, we shall not follow the reporters in their detailed examination of the several projects submitted to their notice, but content ourselves with a quotation of the conclusions they formed. And first we will direct attention to the lines proposed to Holyhead and Orme's Head.

"Owing to the nature of the country, the lines of Mr. Stephenson, Mr. Giles, and Mr. Jenkins, are for many miles nearly identical.

"The three lines commence at different points, and gradually approaching each other meet about midway between Chester and the Upper Ferry. Mr. Giles's line commences in the Crewe and Chester line at about three miles from Chester, and crossing the Dee by a viaduct of masonry, arrives, without any severe inclination, at the Upper Ferry about one mile beyond Chester.

"Mr. Jenkins's terminus is likewise to be on the Crewe and Chester line, at about two and a half miles from Chester. He proposes, also, to cross the Dee above the city, on a masonry viaduct, and descend towards the Upper Ferry, commencing by a fall of three-quarters of a mile in length, at the rate of 1 in 97.

"The terminus selected by Mr. Stephenson is that of the Chester and Crewe and the Chester and Birkenkead Railways."

Having followed the projected lines of Mr. Giles and Mr. Stephenson, from their junction with the Crewe and Chester line to their western terminus, the reporters are brought to the opinion that the line proposed by Mr. Stephenson is preferable, on account of its offering a greater facility and economy of construction.

"This line has, in an extent of 85 miles, only 1,504 yards of tunnel, whereas that of Mr. Giles has 8,538 yards, in the same distance. The gradients of both lines are favourable."

We must now turn to the opinions formed from an examination of the proposed lines to Port-dyn-llaen. The first line examined by the reporters was that from Port-dyn-llaen towards Shrewsbury, projected by Mr. Vignoles. This gentleman's section only extends to Bala, but it is continued by Mr. Stephenson to Chirk.

"The next thirty miles, namely, from Chirk to Shrewsbury, have

not been surveyed with a view to the formation of the railway now under consideration, and therefore we can offer no opinion as to the line that might be selected in this part of the country; but a survey, on which Mr. Locke has reported, has been made from Wolverhampton to Shrewsbury.

"This report, and a section of the line as prepared for parliament, were laid before us, but we do not think it necessary to give a detailed description, or an opinion on this project, as it has not the sanction of Mr. Locke's recommendation. We will therefore only observe, that from an examination of the country between Wolverhampton and Shrewsbury, it does not appear that any great engineering difficulty would have to be encountered; and as it is a line that, in our judgment, could not fail to be very beneficial to the district through which it would pass, we consider it probable that it will eventually be executed."

The next line examined was that from Bangor *viâ* Caernarvon to Port-dyn-llaen, proposed by Mr. Archer, and surveyed by Mr. Purdon, under the direction of Mr. Vignoles. Having described this line in detail, the reporters state, that "it appears to have been selected with much judgment."

"It is now necessary," they say, "to consider how it could be made a portion of the great chain of communication between London and Dublin.

"We have expressed our opinion, that the best line from Chester to Bangor is that proposed by Mr. Stephenson, and therefore it is with this line that the Caernarvon line (as we shall designate that advocated by Mr. Archer) would have to form a junction, if Port-dyn-llaen should be selected as the station for the Dublin packets.

"It has been already stated, that the Caernarvon line commences at the Bangor road, near the corner of Penrhyn Park; but it unfortunately happens that at this point it is 80 feet above the level of Mr. Stephenson's line.

"No plan has been laid before us by which we could determine the best mode of connecting the two lines; but there is no doubt that the junction might be effected by using an inclined plane, or by bringing Mr. Stephenson's line by steeper gradients than those proposed by him up to the level of the terminus of the Caernarvon line. In both cases, however, this difference of level operates as a defect in the project now under consideration, which is not attributable to any mismanagement on the part of the engineer, but to the state of the country."

The next line examined was that from the Great Western Railway by Oxford, Worcester, Newtown, and Dolgelly. It is proposed to connect this line with the Great Western at Dudcot, about 52½ miles from London, and to join the line projected by Mr. Vignoles a few miles to the westward of Dolgelly.

Upon a comparison of the three lines the reporters came to the following opinion:—

"As regards the extent of new railway to be formed, the facility and economy of construction, and the time to be employed in the work, the preference should be given to the route by Chester, Bangor, and Caernarvon; and with the single exception of time to be expended in the journey, in which the advantage would be decidedly in favour of the Worcester line, all the tested properties are in favour of that by Chester, Bangor, and Caernarvon.

"After a careful review of all the bearings of the case, we feel bound to state, that the route by Chester, Bangor, and Caernarvon is, under present circumstances, the preferable one for a railway communication to Port-dyn-llaen."

We are now brought to a comparison of the lines to Holyhead with those to Port-dyn-llaen. This most important question has unfortunately been answered in reference to the reports made upon the suitability of the two places for a harbour, and not entirely by a comparison of the advantages of the several lines. But at present we must confine ourselves to the statements of the reporters.

"It is now necessary," they say, "to advert to the Report of the officers of the Royal Navy who were directed, in pursuance of the Address of the House of Commons of the 12th August, to give their opinion as to the relative merits of the three ports therein specified, namely, Holyhead, Port-dyn-llaen, and Orme's Head.

"In that Report, dated the 14th January, 1840, which has been officially communicated to us, we find that they consider the formation of a packet station at Orme's Head wholly out of the question: it is therefore unnecessary for us to make any further remark on that subject.

"If the naval committee were of opinion that the harbours of Port-dyn-llaen and Holyhead could be rendered equally suitable for the station of the Dublin packets, it would be necessary for us to enter into the most minute and searching examination of all the properties of the two lines from Bangor, in order to ascertain to which the preference might be due. In this case we should require the advocates of these competing lines to lay before us detailed estimates and drawings of every part of the work that their respective projects would involve, with other information, to which it is now superfluous to advert.

"The Report of the naval committee is, however, so decidedly in favour of Holyhead, that it is unnecessary to put the parties in question to the expense of preparing the drawings, &c. we have alluded to, because, although we are, for want of this minute information, not in a situation to state which of the two lines would be preferred,—seeing that the advantages and disadvantages are nearly balanced,—we yet are enabled distinctly to say, that there is no mechanical or statistical superiority in one line over the other, that could turn the scale against either harbour that might be considered most advantageous for the packet station.

"We have now to state, that in obedience to the order of the Lords Commissioners of the Treasury, dated the 12th February last, we have carefully considered the arrangements submitted to their Lordships by the naval committee for the proposed extension of the harbour at Holyhead; and we have to report, that so far as we are competent to judge of this matter, it appears to us that the project in question is well adapted for effecting the objects which these officers represent to be necessary."

Whatever may be thought of the conclusion of this apparently elaborate and certainly very profitable and pleasant inquiry, every one will believe that the reporters know how to say what they are told. But we reserve our remarks for another opportunity. Mr. Walker, the engineer to the Admiralty, has since been employed to report upon both the harbours and the railways. That portion of his Report which relates to the former we have already published, and have now only to add his opinions upon the latter.

"I have now to comply with the part of your instructions that has reference to the communication by railway from the two harbours, and, as I have already stated, this branch must be imperfect, from my not having yet received any plans of an inland or south line. To the coast line I have given considerable attention. Mr. Stephenson and Mr. Giles have each proposed a line from Chester to Holyhead, and each has been reported on in detail by Sir F. Smith and Professor Barlow. I have marked upon the Ordnance sheets which will be delivered with this report Mr. Stephenson's line by yellow, and Mr. Giles' by red lines. Nearly the same line was suggested, and is described by Mr. Vignoles in his report of November 1837, to the commissioners for inquiring into the subject of railways in Ireland.

"Both lines, after leaving Chester, follow the west course of the Dee, through Flint, pass under Holywell to Mostyn Quay, go round inside the point of Air, thence straight to the south of Rhyl, and continue along the coast till within a few miles of Conway, when they proceed to the south side of Conway; after passing which they approach the coast, and continue along it to near Penrhyn Park, which they leave on the north or sea side, and proceed through or near Bangor to the present Menai Bridge; after crossing which, they leave the turnpike road to get to the low ground on the south side of Anglesea, the greatest distance from the road being at 2 miles west of Mona, where they are 3½ miles to the south. From this point they again approach gradually the turnpike road near Holyhead.

"My decided opinion of the railway, as of the harbour, is that the best line should be selected, and that the railway should be made in

a good manner as a great public work. I believe that the cheapest way might be to do the work well, even if the traffic expected upon it were for some time small; but I think the traffic upon this line will be great and increasing; indeed, that for all but the lowest class of passengers, it will be the general mode of conveyance from all parts of Ireland to England. The north of Ireland is the most out of its influence, and yet five hours between Belfast and London will be saved by going by the railway from Belfast to Dublin when completed, crossing to Holyhead, and then taking the railway to London. The case for the south and west of Ireland would of course be still stronger. Then there is the trade of passengers and goods to and from Holyhead, should the harbour be extended and used as I have referred to. It is a mistake, therefore, to suppose, that carrying the mails will be the principal business, or that the mail trains will be the only trains. The Holyhead and Chester line, if this be the line finally adopted, may, when it has attained the same maturity, be nearly as good a line for trade as some of the lines which it will join now are; and that it will be at once a valuable tributary to them all cannot be doubted. I name the above, from seeing in Mr. Bidder's evidence on Mr. Stephenson's plan, that there has been a proposal of having only one line, with passing places,—an expedient which may have a saving in first cost to recommend it, but which the danger, the difficulty of repairing, the uncertainty, and the delay, ought much to outweigh. Also, in place of the very circuitous line which has been proposed at Bangor and the Menai Straits, and drawing the trains by horses, or by a fixed engine, up the slope and along the present bridge, which was built, and should be kept for the turnpike road, I think the line should be continued direct to the straits, and the straits crossed by an arched bridge built for the railway. The unfitness for a railway of the present suspension bridge, which is approached by a slope of 1 in 25; the interference by engines and trains with the present use of it, which interference will, I am sure, be more frequent and annoying than appears to have been contemplated; the delay at all times, particularly in stormy weather; the having to cross Bangor with an embankment 70 feet in the deepest part; the numerous curves to reach the bridge, and the repetition of similar curves on the Anglesea side, are all objectionable. I think neither the Holyhead road, nor the Menai bridge, should be injuriously interfered with. The district, and the traveller who does not wish to go at railway speed, ought not to be deprived of the facilities they have had upon the turnpike roads, which the change of fashion may make more used than at present, besides being some check upon tendency to monopoly and its effects. I have shown the circuitous line, and the more direct line recommended by me, upon the accompanying plan (No. 4). The railway bridge may cross at the Swelly or Gorred Goch rocks. The position and width of the latter are taken from a survey by Mr. Vignoles; they are nearest the direct line. The late Mr. Rennie and Mr. Telford both proposed fixed bridges over the straits; the cost was, I believe, the objection. The ironwork of bridges may be done now at half the cost, and the traffic will be very much greater than was then calculated upon.

"I think Mr. Stephenson's plan* of terminating on the west, better than that of Mr. Giles, which takes the east side of Holyhead harbour.

"Mr. Giles' plan of leaving the Chester and Crewe line before reaching the city of Chester, is much to be preferred to Mr. Stephenson's, which passes to the west of the city, and turns back through it by curves and works of considerable difficulty. These, if not objectionable to the citizens, are of an expensive nature. The distance from Holyhead to London, and to all the principal towns, excepting Liverpool, is one mile shorter by Mr. Giles' than by Mr. Stephenson's plan here; and of all places Liverpool is, from having the direct sea communication to Dublin, least interested in the question. By Mr. Giles' line there is one mile less of railway to make here. The accompanying plan (No. 5) shows the directions of the two lines near Chester.

"Short tunnels through the points of Penman Back and Penman Mawr will, in my opinion, be preferable, in respect of dispatch and safety, to embanking outside the perpendicular cliffs, which are heavily struck by the seas.

"The gradients for both lines are unobjectionable. A very detailed and clear account of each line is given in Sir F. Smith's and Professor Barlow's report, which contains also a proof of the sufficiency, as a question of statistics, of the chains of the Menai Bridge to carry the railway trains.

"Mr. Stephenson's line, through Anglesea, is not so straight as Mr. Giles', but the difference in cost would, in some places, be greater than the advantage by the straightness: a medium course may be the best. Near the Menai and approaching Holyhead, Mr. Stephenson appears to keep unnecessarily near the road, for the safety of travellers upon it.

"I avoid troubling you with further details. If the Government be a party to any contract, the line as well as the terms will, no doubt, be settled with due reference to the public in the conveyance of passengers as well as mails.

"If the harbour works be done in a good manner at the public expense, the railway to it should correspond; whatever is expended in improving and enlarging the harbour will be beneficial to the railway, by increasing the traffic upon it; and if the railway is to be made by a joint stock company, there will, I apprehend, be no difficulty at present in obtaining offers from parties who would be ready, with the aid of a fair compensation for carrying the mails, to undertake the work upon a plan approved by the government. To have parties who are influential upon the present lines, so that the public convenience may be secured for the whole length, might be an advantage.

"As the survey of the inland line of railway is unfinished, I have not inquired into the working of the Great Western Railway, but I have into that of the London and Birmingham, and I have received every facility and attention in doing so from Mr. Glyn, the chairman, Mr. Creed, and Mr. Bury, with an expression of readiness to consider liberally any suggestion that might be made. A few which I named and will now state were received in this spirit.

"Ten minutes are allowed for the first mile from Euston-square, on account of the stationary engine work; this is at the rate of six miles per hour; it may be done and often is done in less time, but the difference is lost at the first stoppage, as the train must wait its time there. Now it is agreed that the locomotive engine might go to the terminus and start at once. This would save five to seven minutes.

"In two hours after starting there is a stoppage of ten minutes at Wolverton, where refreshments are supplied and invitingly served; less than half the time would do for changing the engine. There is no similar stoppage between Liverpool and Birmingham, although Birmingham is nearly equidistant from London and Liverpool.

"The arrangements near Birmingham are still more unnecessary and more tedious. Here the up and down trains are taken off the direct course to the Birmingham station, to a point which obliges the carriages to be turned round upon turn-plates; half an hour is usually allowed for this and for refreshments. These operations being finished, the train returns along a curve upon the Grand Junction Railway to the valley of the Tame. In addition to the stoppage, we have had $2\frac{1}{4}$ miles of unnecessary travelling, the straight line or base of the triangle being $2\frac{1}{2}$ miles, the two sides which are travelled $4\frac{3}{4}$ miles. I see no reason, except "the good of the houses," why the mail, or a traveller to Liverpool and Dublin, should be kept ten minutes at Wolverton, and then be carried two miles out of his way in two hours afterwards, to be refreshed for half an hour at Birmingham.* Delicate persons, requiring frequent and long stoppages, will have the opportunity of travelling by other than the mail trains. Between eight o'clock, P.M., when the mail coaches upon the road leave London, and the same hour in the morning, no time is allowed but for changing horses. If a few minutes be taken at some one place, it has to be made up for on the road. This may be the other extreme and insufficient; it is worse than having no stoppage, exceeding five minutes, between London and Holyhead. Even Birmingham, for the sake of conciliating which the Birmingham detour was made at the time, will, I think, agree that its convenience would be answered by having the Birmingham carriages to detach from the train. The accompanying

* If there is any inaccuracy in my statement of Mr. Stephenson's line, it must be ascribed in part to my not receiving from him any explanation of his line, beyond what the documents which he had previously sent in afforded me.

* There is no Post-office arrangement requiring so great a delay.

plan (No. 6) illustrates my remarks on the Birmingham detour. In justice to the railway companies themselves, and to such of their passengers as are desirous of "getting on," the cut ought to be made now. The companies can afford it; I have had it surveyed. The execution would not be expensive, considering its importance. There are no buildings in the way. By the above and the alterations lower down to which I have referred, the worst curves between London and Holyhead will be avoided, and the distance reduced nearly five miles.*

"Then as to speed:—

"The London and Birmingham Company began very prudently at 18 miles per hour; the work was new to them; they rose to 20, then 22½; the last return of their mail trains was 26¼. With the exception of their power being occasionally too small for their loads to ensure punctuality, their work has been regularly, safely, and creditably done, so far as I have observed or heard, and has progressed steadily; their concern has paid well, and they appear disposed to attend to what the public convenience requires of them. The present Great Western speed is 29. These include stoppages.

"There is, in my opinion, nothing in the difference of gauge of the two railways to prevent the Birmingham and Grand Junction being as quick as the Great Western, if they would apply sufficient power. That the directors think so is evident from their allowing a speed of 40 miles per hour to be run when the inclination is in favour. The Northern and Eastern return 36 miles as their speed, exclusive of stoppages. My observations upon this railway, and part of the Brighton, and also of the South-Eastern, make the speed vary from 36 to 40, and occasionally 42. The Great Western is often 45; on special occasions it is still more.

"The following calculations of time and speed are meant to refer to the mail and fast trains only. I propose to show that after the extension and improvements to which I have referred are made, the journey between London and Dublin may generally be made in 14 hours, and that the answers to letters posted in the evening may be received by the morning delivery, after one day's interval.

"By the received measurements of the present railways, and of the ordnance map from Chester to Holyhead, the distance between London and Holyhead, allowing for the straightening at Birmingham and other places, will be 267 miles, which at 36 miles per hour, is 7 hours 25 minutes.

Add one stoppage of 15 min., two of 10 min., two of 5 min., and five of 4 min.	1 h.	5 m.
Makes between London and Holyhead stations .	8	30
Or $31\frac{7}{17}$ miles per hour, including stoppages.		
Allow for crossing to Kingstown and reaching the Dublin Post-office	5	30
Is from Euston station to Post-office, Dublin .	14	0
Allow time in Dublin	5	0
Journey back to Euston-square	14	0
Making the journey from Euston-square to Dublin, and back to Euston-square	33	0
According to this if the train leave the Euston station at P.M., the present time for departure,	8	30†
The mail would be in Dublin Post-office at . . on the following morning.	10	30
It would leave at . . . . in the afternoon,	3	30
And arrive at Euston at . . . . next morning, being the present time for arrival there.	5	30

"Some modification may be required in the above detail, but a very small allowance upon the present speed is required to justify the conclusion as being practicable. Whether the Great Western course will produce something still superior, remains to be shown, when I have the materials for making the calculations; but to have taken the Birmingham and Grand Junction lines, without including the improvements of which they are capable, would have been unfair, as I think the Birmingham and Grand Junction companies will see it to be their interest to make these improvements, because, without them, the above results for the time of the mails between London and Dublin could not have been brought out.

"I named having inspected the country between Bangor and Port-dyn-llaen, which has been surveyed by Mr. Vignoles and Mr. Purdon for a railway. A higher level near Penrhyn castle must be kept to accommodate this line: but, after getting through the hill above Bangor, which, according to my opinion, the Holyhead as well as the Port-dyn-llaen line should encounter, there is no difficult feature for a great length. The line keeps within a short distance of the turnpike road which skirts the Menai Straits, and Caernarvon Bay, except near Caernarvon, which it passes 1¼ mile east of the town.

"The country is favourable, very much more so indeed than its vicinity to mountains would have led me to expect. The only difficulty of a formidable nature is the Rival mountain, which the engineers manage by keeping close to the shore, where the mountain is so narrow that only two short tunnels, together one mile in length, are required. There is also a deep and difficult cutting west of the Rivals, two-thirds of a mile long, through rock. The greatest inclination is 1 in 400.

"The length from Bangor to Port-dyn-llaen is four miles greater than to Holyhead, but of the two I consider that to Port-dyn-llaen the easier; and if an inland line to Holyhead, whether through Worcester or Shrewsbury, can be shown, which shall be as good as by far the greater portion of the Bangor to Port-dyn-llaen line, it will be superior to the coast line, which has some heavy rock in parts, and which, in some places upon the coast, will be much exposed to storms."

There are many curious statements in this portion of Mr. Walker's Report, and particularly when compared with the opinions of Sir Frederic Smith and Professor Barlow, but for the present we delay our remarks, which will give the reader an opportuuity of studying the suggestions and evidence contained in the accumulated wisdom, not of the heads of the professions, but of the heads by which the profession is governed.

OBSERVATIONS AND RESEARCHES CONCERNING THE PROLONGATION OF THE LINE OF RIVERS INTO THE SEA.

TRANSLATED FROM THE ITALIAN OF ANTONIO MARIA LORGNA.

(Continued from p. 330.)

VII. The first three propositions, drawn from observation, led to the fourth, the facts which I had ascertained serving as a step to the knowledge of a truth which could not, perhaps, have been discovered without the intermediate processes. For this reason, and because the importance of the subject demanded it, I have dwelt long on these investigations, and not less with the hope of making the subject so clear, that no reasonable doubt could be entertained of the effects. If, then, it be true, as we have stated, that after the prolongation of the mouth in B (fig. 2), it is not possible that the bed can be re-formed in the curve BIPM, of exactly the same form and similarly placed to DPHL, the work being disturbed by new conditions constantly arising, it will be at least evident, as may be easily proved by facts and reasonings, that although there is an excavation of the bed, as at DI, where there was first a bank, a new elevation is produced at the opposite extremity of the trunk MN; and also that in the intermediate parts, from P, which we take as a limit, downwards, there will be an excavation, and on the other side an elevation of the bed. The alternations and modifications (§ 6) which occur in the intermediate and almost horizontal trunks are then clearly defined, and by them the effect of the prolongation is transferred to the superior trunks. At first it will appear that the

* The line that was projected from Stone to Rugby would save seven miles, by making sixty miles of railroad.

† All Greenwich time. Dublin time is 25 min. 22 sec. later. Much confusion and disappointment would be prevented by the clocks in the United Kingdom being all kept to Greenwich time; the true time for astronomical purposes might also be shown upon the dial.

excavation in the trunk upon one side of the point P, and the filling up of the bed on the other side, must be so small as to be scarcely perceptible, and that the bed of the river beyond must for miles appear quite unaltered. But if, on the contrary, observations were made at the two extremities of the trunk, namely, towards the mouth on the one side, and near the place where the horizontal line of the low water of the sea touches the bottom of the river, on the other side, it would be evident that a change had been produced in one of depressing and in the other of raising the bed, and that the prolongation of the line of the river had effected this, without any remarkable alterations in the intermediate parts.

VIII. But it must be remembered, that by the effect produced upon the inclined superior beds, modified in the manner already explained, the intermediate trunks are rapidly increased. There is no doubt that in this way the beds, as at M N L, are slowly brought into contact with the almost horizontal channel, and that they are in fact united to the bed immediately above. Thus the line of the inclined bed of the river effectively prolongs itself. We may then see how the elevation of the bed necessarily follows, in the superior trunks, in consequence of the modification in the trunk interposed between them and the mouth. If it were not so, and if such successive repetitions of the same phenomenon, more and more forward into the sea, did not happen on one side, and if one could not verify, on the other side, the progress of the inclined beds of our turbid rivers, beyond the point L, the extension of the last trunk of a bed almost horizontal would not, contrary to experience, have any limit.

IX. Extensive observations on the Po of Lombardy confirm our proposition, and illustrate the effects we have attempted to exhibit. This great river, within a distance of sixteen miles from its mouth, is divided into two branches, one called *Fornaci*, and the other *Ariano*, and of these the former is the principal trunk, the other being a very inferior branch. Accurate observations on this river, from the beginning of the present century, are not wanting, and from these it may be deduced that the branch Ariano has been much deepened. In 1716 it was found to be considerably more excavated than it was in 1693, comparing together the observations made at the same places in the two different periods. (Visit of M. Riviera). And in the last visit, in 1721, it was found to be deeper than in 1716. Every one who has reflected on the subject must be convinced that, while on one side the line of the Po was being prolonged into the sea, the branch Ariano lowered its bed; but this phenomenon was repeated about the middle of the last century, at the time of the introduction of the waters of the Panaro into the Po of Lombardy, the other streams being drawn off by the Po of Ferrara. I do not deny that there was an enlargement of the bed of the Po in proportion to this addition of water, according to the principles enforced by the learned men who have written on this subject. But it must be remembered that these additional waters were not all carried towards the sea by the branch Ariano, which was at that time in a very disadvantageous condition, the waters having a much more easy discharge by the trunk on the left hand, which is more ample, deeper, and incomparably more active. The depth produced in the places we have mentioned is too remarkable to be attributed entirely to the action of the water which had entered the Ariano.

To this consideration must be added, that it is not the usual operation of nature to employ almost a century, which was the period that elapsed between the first introduction of the Panaro and the last observations made upon that branch, in giving the bed of a river a proportion suitable to the determinate increase of its waters; particularly in the last trunks, where the arrangement of the shores, and a bed of moveable matter, such as mud and sand, co-operate with the causes already mentioned. We may then, in illustration of this subject, refer to the Panaro. But when we reflect on the effects produced in the Adige in the short space of four years, as shown by my observations, and on the legitimate consequences I have deduced, by sound reasoning, from these observations and other facts, there can be no doubt that the remarkable excavation of the bed in the Po of Ariano, observed during these last years, followed the prolongation in the manner I have already explained. This must be the more evident, as every one acknowledges that the mouth of the Po was in a short space of time considerably protracted into the sea, almost four miles in a century. And in fact, considering the position of this bed, that it is only 16 or 17 miles distant from the sea, and the great distance at which the horizontal of the low tide of the sea touches the bed of the river in the other trunk, which is between Stellata and Lagoscura, a distance, as we have said (§ 5), of sixty miles, it seems that a deepening of the channel of the Ariano must have been the consequence of the remarkable displacement of the mouth of the Po. In the same manner we should have had a full confirmation of this most important theory between Stellata and Lagoscura, if more extensive and accurate observations had been made upon the successive alterations of the bed. But this question is now put in such a light, if I am not deceived, that for the future it will no longer seem an object of mere curiosity to ascertain the system of established waters in rivers which discharge themselves into the sea, and to point out with precision the state of the superior termination of the last trunk, by the advancement of which the elevation of the superior beds is occasioned. Admirable indeed, as we have seen, is the agreement of the effects at these two termini, between which the river flows in the last trunk, and we may conclude, not without reason, that the beds of our rivers are effectively prolonged and advanced into the sea.

MR. BROOKS'S REPLY TO "THE ATHENÆUM" ON THE IMPROVEMENT OF RIVERS.

[It is the custom of "the Athenæum," for very evident reasons, to refuse the insertion of replies to its criticisms, and this is a rule which can scarcely admit of an exception. We have been requested by Mr. Brooks to give insertion in our pages to a letter of this kind, and as it may be considered a defence of his theory, we have done so; a course which will not we are sure be objected to by the conductors of that admirable Journal.]

TO THE EDITOR OF THE ATHENÆUM.

Sir,

I have just perused your review of my work "On the Improvement of Rivers, and New Theory of the Cause of the Existence of Bars;" and had you in it advanced any proof that my theory is not a *new* theory, I should have no just cause of complaint. I now beg of you to promptly bring evidence of any professional man or writer on the subject ever having previously published or held the views which I have propounded as my own, and published them two years since.

In your review you appear to be giving your own plans for *the improvement of the* BARS *of rivers;* but the treatment you advance is, I repeat, that first propounded by myself.

You will find that Smeaton and other engineers, *in reference to the improvement of bars*, recommended quite opposite courses, viz., the construction of dams across navigable rivers, provided with sluices; whereas my plan is the removal of all inner dams or shoals, whether natural or artificial. In what report will you find a previous statement that the presence of a bar is owing to the features pointed out in my theory?

In your review you say, "If we have rightly extracted his meaning, then we *cannot* agree with him that it is *new*, nor, as a general theory, *true*."

That my theory "is not new," and of general application, rests for you, Sir, to prove; and that you do not really doubt the correctness of my theory is also shown by your adoption of my remedial measures, notwithstanding the anomaly of your also using the following language, viz., that you "cannot altogether admit the author's theory, or its assumed novelty, nor subscribe to the efficacy or value of his remedial processes, in so far as they pretend to novelty;" and yet you write, "*It is plain, therefore, that the cure of these evils will be to alter the river so as to place the stream in a condition resembling, as nearly as possible, the state of such as are free from these impediments.*" If we find the course of the river suddenly arrested by the ocean, so as to deposit a bar at the place where its waters are thus stopped, it is plain that we should endeavour to deepen, widen, and lengthen the space in which this arrestment takes place; the *channel is to be deepened above the bar*, the bar itself should be reduced by artificial means in the first instance, so as to co-operate with us, and works carried on, *so as to cause a stream at all times during ebb and flow* across that place where the bar was formed. *The channel may thus be made to deepen gradually*, to widen gradually; AND THE SURFACE OF LOW WATER TO FALL GRADUALLY; *thus the deposit on the spot where it formerly existed will cease, and the river remain clear.*

Further, you again partially adopt my views, and I shall, as in the previous extract, place in italics the language which you use where it coincides with my own statements on the same subject. Thus you write, when treating of the removal of the bar: "Above all, the deepening of the channel and uniting its waters, *the graduation of the bed and the surface* to an increasing action *and a diminishing slope, are the great elements of improvement.*"

Now, Mr. Editor, until you bring forward some party who held my theory on the cause of the existence of bars previous to its being propounded by myself, I shall claim the high honour of your having adopted my views, which I will now prove by a comparison of your language with my own, beginning with my description of the features of a river which has no bar at its mouth.

"Resuming the investigation into the state of a river whose entrance is free from a bar, we shall find that from its junction with the ocean a long line of navigable course exists, *with an extremely gentle fall, or slope of its surface at low water.*" Again, "*The river being in this perfect state as regards the slope of its surface at low water*, a consequent attendant upon the latter will be an equal duration, or nearly so, of the period taken up by the flow of the flood tide with that of the ebb in the lower reach of the river; by the term flow being understood the direct upward course of the current of the flood tide immediately after the true time of low water. *Assuming that to the possession of a nearly equal duration of the period of ebb and flow in the lower reach of a river, accompanied by an extremely gentle inclination of its surface, is to be attributed the freedom from the incumbrance of a bar, &c.*"

It is from the above extracts of my work that you adopt my *modus operandi* for the removal of a bar, viz: *the bringing of the features of a bar river to resemble those of a river free from a bar*—as above defined, and this you allude to in your words, "above all the deepening of the channel and uniting its waters, the *graduation of the bed and the surface* to an increasing action *and diminishing slope*, are the great elements of improvement."

And further: "*And works carried on so as to cause a stream at all times during ebb and flow across that place where the bar is formed.*" This evidently refers to the necessity of the flood and ebb currents being made to hold their course in periods of equal duration, or that there shall not remain any length of time during which the two currents can remain in opposition to each other.

The whole of my theory on bars, and my remedial measures, may be deduced from the definition I have given of the state of a river free from a bar, as my object is, as you have also given it, simply to reduce to the features of a river free from a bar, those of a river encumbered with one. This is effected by the removal of the inner bars, or shoals, which are the cause of the existence of the great slope of the surface at low water, and consequent preponderance of the duration of the period of the ebb over that of the upward current of the flood; which preponderance, I notice, is invariably found in bar rivers.

My theory shows, that the deposit or formation of the bar takes place during the early division of the flood-tide at sea, or at the mouth of the river, when the tide-current is prevented from setting up the channel, owing to its encountering, or being in confliction, with the still ebbing waters; and it therefore follows, that the period of confliction of the two currents at the mouth of the river is altogether dependent upon the state of the slope of the river's surface at low water, or is altogether dependent upon the perfect or imperfect discharge of the backwater; and that discharge must be imperfect so long as the water is pent up, or dammed back, by shoals or inner bars.—The reduction of the slope of the river's surface at low water, and attendant free admission of the flood-tide, is therefore a consequence of the removal of the inner bars, and therefore I wrote chap. 7,—"On the Course to be adopted for the Improvement of the Depth on the Bars of Rivers, and in their Channels." "The reasoning in the preceding pages on the cause of the formation of bars, suggests the course to be adopted for their amelioration by the removal of all those inner banks, or shoals, stretching like dams across the river, which have the effect of preventing the rapid discharge of the backwater during the proper tidal duration of the ebb. Where this is judiciously undertaken, an improvement must take place, not only within the river, but on its bar. I think, Mr. Editor, that after a perusal of the above extract from my work, you will withdraw your observations relative to any mere treatment of symptoms in my "hydropathic practice," and that a further perusal of my work, should you so honour me, will convince you that it not only points out the necessary removal of the shoals, which cause the great slope of the low water surface, but also shows how to remove the causes of the formation of the shoals in question; and that in my practice no dredging operations are necessary, except where the bed of the river happens to be of too hard a nature to be removed, without a too violent contraction of the width of the stream. Requesting the honour of the insertion of this letter in the pages of the *Athenæum*, I remain, your obedient servant,

WILLIAM ALEX. BROOKS.

Guildhall, Newcastle-on-Tyne, 14th Oct. 1843.

LOWE'S PATENT SHIP PROPELLER OF CURVED BLADES.

TO THE EDITOR.

SIR,

THE attention of scientific men, which was so long directed to the improvement of the paddle-wheel for the propulsion of vessels, is now almost confined to the application of the propeller. The form which I believe to be destined to supersede the paddle-wheel, is the invention of Mr. James Lowe, patented on the 24th of March 1838, and described as "the sections or portions of a screw, or curved blades, each a portion of a curve, which, if continued, would produce a screw." Experiments have proved it to possess all that is essential for a ship propeller, viz., speed and security. These properties in Mr. Lowe's patent invention are uniform and permanent; but it has also the not less advantage of great economy in fuel and engine room.

In all the various trials it has undergone it has been successfully worked. In violent storms at sea, and upon lee shores, it is so perfectly manageable, that it must be preferred to every other mode of propelling vessels.

The Archimedian or whole screw, as patented by Mr. F. P. Smith, has had a host of literary supporters, who have endeavoured to introduce it into public notice, but, like most things without intrinsic merit, it has sustained but a momentary notoriety. Mr. Lowe's invention, unprotected by any special care, has outlived its numerous assailants and pirates. Many attempts have been made to deprive him of his right to the invention of the propeller of curved blades, and there have been instances in which it has been applied under other names to vessels, for the purpose of obtaining credit for worthless inventions.

The screw propeller, for which the Ship Propeller Company has a patent, and upon which the enrolment by Act of Parliament was settled, is one that was patented by Mr. F. T. Smith on 30th Nov.

3

1836, and is composed of a whole undivided screw or worm, as set forth in the specification, from which the following extracts are taken:—

"I, the said Francis Pettit Smith, do hereby declare the nature of my said invention to consist of a Screw or Worm, to revolve rapidly under water in a recess or open space, formed in that part of the after part of the vessel commonly called the dead rising or dead wood of the run.

"And whereas the propeller may be made of wood, sheet iron, or other suitable material, and with a greater number of threads or worms, and set at various angles with the central line of the screw: But whereas I claim as my invention the propeller hereinbefore described, whether arranged singly in an open space in the dead wood as here shewn, or in duplicate with one on each side of the dead wood, or otherwise placed more forward or more aft, or more or less deep in the water."

This was followed by Mr. Lowe's patent, dated 24th March 1838, for a propeller of the sections or portions of a screw. It will clearly show the distinctive character of it, and all devices or combinations, being sections or portions of a screw, and less than a whole turn or worm, or any curved blades which, if continued, would produce a screw, cannot be made, vended, or used as submarine propellers for ships, &c., without coming within the exclusive patent right of Mr. Lowe's invention.

That which Mr. Smith calls his plan was introduced at an early period of steam navigation, and with a uniform result, proving its unfitness to obtain speed. The fate of the Archimedean is well known.

Mr. Lowe's curved blades or portions of a screw, removed all the difficulties of applying a sub-marine propeller, by allowing the water to pass away. This was tacitly if not openly avowed by all persons interested in the subject. In May, 1839, Mr. Smith, under the disclaiming act, thought to improve his invention by cutting his whole screw into two parts, and adopting portions of a screw, or "half turns" as he calls them; and since that time has, I believe, employed a great variety of forms, which cannot be with propriety done, as Mr. Lowe's patent was taken out in 1838. It is expressly laid down in the 5& 6 W. IV. c. 83, that alterations and disclaimers on specifications of patents shall not confer an extension of the exclusive right of the patent. The original patent of Mr. Smith was for a sort of worm or screw; but the disclaimer substitutes a propeller of "two half turns" or sections, which if continued would produce a screw. This is surely more than he could demand, for Mr. Lowe's patent preserves to him all sections or portions of a screw whatever, which by continuation would produce a screw. If such a disclaimer can be allowed, I do not understand what can be the value of letters patent.

The subject of the screw as a propelling power to ships resolves itself into the question: Whether the screw shall be a whole one, according to Mr. Smith's patent, or sections of a screw, in the form of curved blades, according to Mr. Lowe's specification? This is substantially the whole case between these patents.

Having paid great attention to this subject, I am of opinion that we are indebted to Mr. Lowe for the available submarine propeller, and I am therefore anxious to draw the attention of practical scientific men to the subject, which I cannot do better than in the pages of your impartial Journal.

Your obedient Servant,

B.

THE BAR HARBOURS OF THE SOUTHERN COAST.

BY W. B. PRICHARD, ESQ., C.E.

TO THE EDITOR.

When Mr. Brooks's present fit of insane anger has passed off, he may perhaps perceive that his ungentlemanly conduct and abusive language concerning "plagiarisms and piracies," will be treated with the contempt and scorn they deserve. I had at first intended to leave his tissue of abuse unnoticed, thinking it not worth my while to involve myself in so annoying and unprofitable a controversy; and nothing but the importance of the subject of Bar Harbours on the southern coast to your scientific readers, and to this great commercial and maritime nation, coupled with my duty to a large number of my friends, the Commissioners, and other gentlemen connected with those harbours, has induced me to take up my pen to write this letter.

Had Mr. Brooks kept to the question of *Shingle Bars*, and answered my leter in your September Number, the matter would have stood in a different position. As it is, however, there are but two points where he has even attempted to reply; *and even* these, as I shall proceed to show, he had much better have let alone until he had obtained data to work upon.

Mr. Brooks states, that it was my intention to insult your readers: whether it was so or not, I will leave them to decide, perfectly willing to abide the issue of their judgment. His assertion that I have not sufficient moral courage to apologize for my conduct, is most ridiculous. I have nothing to apologize for, seeing that, as I stated before, *and again repeat*, my Report on Shoreham was written without my ever having seen Mr. Brooks's book, and therefore without the possibility of my pirating (as *he* terms it,) a word from it.

It is, in fact, Mr. Brooks that ought to have the moral courage to apologize to me for his unwarranted attack, and likewise to the profession generally for the disgrace he has brought upon it by his mean mode of fishing for practice.

To expect, however, that Mr. Brooks will apologize for his professional delinquencies, is useless; seeing that, if we may judge from the statements of several members of the corporation of Newcastle, this mode of dealing is not new to him.*

Mr. Brooks states, that he will "show how little acquaintance he (Mr. Prichard) has with the subject on which he treats."† Now the subject that I treated upon was the *Shingle Bars* of the southern coast, and although Mr. Brooks has presumed to give judgment that I have but little acquaintance with the matters, I should be sorry to be compelled to come to his school. And that I do not dread his criticism, I here publicly challenge him to discuss, in the pages of your Journal, or any other, the question of the formation and prevention of *Shingle Bars*, and, should he deserve it, I will afterwards enter on the question of bars at the mouth of harbours generally, of whatever material formed.‡

Mr. Brooks attempts to answer my question, as to the disagreement of his theory with the case of Newhaven harbour, by quoting an extract from the Report of Mr. Smeaton, but neglects to state that the Report was made 76 years ago, and that the port has since undergone great alterations.

The fact is, that no harbour from the Thames to Portsmouth has in the last few years been so much improved by the deepening of its channel, and the reduction of its bed in its lower reaches, as that of Newhaven harbour. Since Mr. Smeaton's Report was written, the tide has been made to flow a dozen miles above Lewes bridge, and the channel in its lower reaches is seven to eight feet lower than it was originally. And although I have no doubt but that Mr. Smeaton's levels were perfectly correct at the time when they were taken, there is at the present day no such inclination as that specified in the report. An actual examination of the state of the river by myself in May last, gave, for the first three quarters of a mile from the mouth of the harbour, a rise of only two inches, and from that point upwards showed a gradual increase of inclination, and, notwithstanding the fall in the upper and lower reaches. has thus been reduced to the extent of nearly eight feet since Mr. Smeaton's time. The bar at the mouth is now as great, and indeed greater, than it was when his report was written. *This fact*, I presume. destroys Mr. Brooks' theory, and bears out the opinion expressed in my last, that "he would find it difficult to explain what connexion the condition of the bed of a channel could have with the formation of such bars, when those bars (unlike the Tyne or Tees) are composed, not of materials derived from the channels, but of shingle impelled along the coast by the waves of the ocean."

Mr. Brooks next states that he has "now shown, from good authority, that Mr. Prichard was completely ignorant of Newhaven harbour and the river Ouse." No doubt Mr. Prichard was igno-

* The quotations from certain speeches at Newcastle, introduced by our correspondent, we have omitted.—Ed.

† A letter on this question has been forwarded to Mr. Brooks.

‡ We shall be happy to give every opportunity for a scientific discussion, but we have a great objection to the continuance of personal disputes.—Ed.

rant of Newhaven harbour at the time Mr. Smeaton wrote his report. But Mr. Brooks should have known that the condition of the river at that day is not its condition at present. Truly it is somewhat presumptuous in your correspondent to state that I was ignorant of the present condition of a harbour situated within eight miles of my residence. I might as reasonably assert that he knows nothing of the "river Wear," close to him; if Mr. Brooks had only read the first four lines in my report, he would have felt the absurdity of such an allegation, seeing that it is there stated that I officially examined *every* harbour on that line of coast in February last, and he must be aware that an official examination comprehends something more than a "bird's eye view." Nay, it is even stated in the report that I took plans, levels, and sections of each harbour, (all of which will be published in January next).

The next matter in rotation which calls for comment, is the somewhat egotistical paragraph concerning what *he* calls "*my* Theory of Bar Harbours." For my own part, I have not the least objection to Mr. Brooks retaining possession of this theory. But that it is not *his own*, and that it is no new discovery of *his*, I am fully prepared to maintain. It was promulgated before Mr. Brooks was born, by Guglielmini, Father Manfredi, and several other continental writers; and also by M. A. Lorgna, a translation of part of whose works appeared in your last number, by W. M. Higgins, Esq., C.E., which translation when completed will fully bear out my assertion. The same view of this pretended *new* theory is taken by the editor of the *Athenæum* in a late article; see the following:—

"If we rightly understand our author, it would appear that he attributes the creation of bars in rivers to the existence of 'an excess of slope which their longitudinal sections present near their embouchures,' and the want of bars to want of this slope. This, as far as we can gather, is Mr. Brooks's 'New Theory on the cause of the existence of Bars.' If we have rightly extracted his meaning, then we confess we *cannot* agree with him that it is *new*, nor, as a general theory, *true*.

"In the first place, the excess of slope, which is stated as a cause of bars, is not of the nature of an efficient cause, but is only in some cases a symptom and consequence of the true cause. This rapid slope of the water surface is an indication of a rapid stream entering abruptly in the waters of the sea, and is, therefore, neither more nor less than an indication that such bar exists, and that the river is thereby dammed up: to adduce this as a cause, and to treat it accordingly, is to mistake the symptoms for the disease,—a mistake as dangerous in the treatment of rivers as of fevers. The maxim of Dr. Hahnemann, that symptoms alone are to be treated, however it may succeed in medicine, does not hold good in engineering, and will not apply to hydropathic practice, however well it may suit the homœopathic.

"In the second place, the symptom, even as a symptom, does not hold good as a general indication, for a bar frequently exists where there is no such sudden slope of the water surface. In all cases where the mouth of the river is wide and very shallow, the width, if sufficient to compensate want of depth and furnish a large section for the discharge, will effect that discharge over a bar without a slope such as our author describes. In such a case his cause is neither the mere cause nor the constant indication.

"But although we cannot altogether admit the author's theory, or its assumed novelty, nor subscribe to the efficacy or value of his remedial processes, in so far as they pretend to novelty, we have nevertheless perused the work with interest."

Judging from the notices to correspondents in the same journal, the following week, it would appear that Mr. Brooks had again lost his *amiable* temper in consequence of this criticism, and the same ebullition of irritation was manifested toward the former Editor of your Journal for his candid opinion to the same effect.

In Mr. Brooks' attempt to answer my question as to the applicability of his *adopted* theory in the case of Littlehampton harbour, he states that "his reply is easily given." Perhaps it may be so; but would it be worth anything? That the condition of that port is not such as to corroborate his theory, will be readily seen by an inspection of the data obtained by me in May last, (being the last time any engineer has examined that harbour). As I before stated, the fall of the river Arun from the mouth averages only 7 inches in a mile. The first mile from the entrance has a rise of less than *one inch*, and afterwards the next 2 miles have a rise of only 3 inches, and the next 4 miles of 5 inches; but the rise gradually increases as you proceed up the river, and the ultimate result is a rise of 7 inches per mile. Yet, notwithstanding the circumstances, the mouth of the river is encumbered with a bar of great magnitude. If this river does not present a "gentle slope," perhaps Mr. Brooks will inform us what he really means by that term.

Mr. Brooks has also the presumption to state that the information obtained from his book has opened my eyes! Truly it is a somewhat wonderful circumstance that I should be indebted to him for my ideas, and yet at the same time differ from him so totally! How does Mr. Brooks explain this phenomenon?

But really, Mr. Editor, this great sportsman of Bar Harbours, as if he was determined to "bag the whole game," has actually the face to claim the concave or west pier, shown in my plan for improving Shoreham Harbour, as being his idea, and having done this, he makes a long and irrelevant parade about your remarks on Bar Harbours, and what he calls *my* book* and *my* work. The fact is, he has got into such a habit of talking about his book, that he cannot even write a report to the River Committee, his employers, without referring to it, just as though every member of the Town Council possessed a copy. See the following extract from his Report to that body, of July 11th, 1843:—"The special committee have, however, only fallen into the now recognized error of Guglielmini, and many other engineers. (See page 122 of *my work* on the Improvement of Rivers.)" Fancy a Report addressed to a number of merchants and shopkeepers, containing references to Mr. Brooks's book, and to the error of continental engineers, as though they were likely to be familiar with such matters. As it happens, however, the *same Report* upon the improvement of the Tyne (which Report and Resolutions I enclose you), with all the learned *allusions* too, and *quotations* from "*my* book," were not received with much respect.

Your correspondent says, that the explanation of the mode of travelling shingle is no discovery of mine, but that it was fully given by Messrs. Smeaton, Palmer, and Col. Williams. Now I have the most profound *respect* for the abilities, writings, and talents of those gentlemen; but I will defy Mr. Brooks to prove that any of them have so minutely and systematically examined the mode in which shingle travels, or that their conclusions are *any thing like* those arrived at by me. The theory of shingle travelling, as propounded by me, is no product of imagination, nor an idea adopted from another writer, but is founded on careful experiments made under my own personal observations in different states of tides and weather, in storm and calm, experiments repeated almost daily for sixteen months, including two severe winter seasons. The result of those experiments are published in my Report, and I am perfectly contented to abide the judgment of your readers (not Mr. Brooks's *self*-constituted judgment) as to the *originality* of my views on this *subject*.

After deducting enormously concerning Newhaven harbour from Mr. Smeaton's levels, which were no doubt correct at the time they were taken, but are far otherwise now, Mr. Brooks proceeds to cast reflections upon my mode of taking sections: I can well afford to laugh at his inuendoes, especially when I find that he is in the constant practice of reflecting upon every body but himself. For proof of this, I may refer to his Report to his own employers, in July last, and to the following extract from a speech of a member of the council:—

"Mr. Philipson bowed to the decision of the chair; at the same time he could not but feel that if their own servants were, as Mr. Ald. Hodgson had correctly described it, to be allowed to criticise the reports of committees, it was a course which, if persevered in, would prevent any gentleman from serving on any special committee whatever. Nothing could be more destructive of harmony and good understanding than for one committee to review the proceedings of another. However, the Council had adopted that course; and now they had before them a further performance of the same kind. They had before them a servant of the whole Council—not of the River Committee—criticising the acts of another committee, appointed by

* Your readers will bear in mind that Mr. Brooks wrote and published a book, as a matter of course for speculation. But my Report was not written for publication, and I have in fact no more to do with it than Mr. Brooks himself, and never have nor ever will receive one farthing of benefit from the same.

the Council. Now, did any body ever hear of such a thing as this, that whereas the Council had appointed a special committee to examine the report of their engineer, yet he should be allowed to criticise the report of the committee appointed to sit in judgment upon himself?"

In conclusion, allow me, Mr. Editor, to say, that if Mr. Brooks can temperately keep to the question of shingle bars, and afterwards of bars in general, no man would be more willing than myself calmly and deliberately to discuss the subject with him. But if Mr. Brooks does not wish to adopt this mode of proceeding, I must decline any further correspondence.

I am, Sir, yours, &c.
WILLIAM B. PRICHARD.

28, *Wilmington Square, Nov.*, 1843.

ABSTRACT OF A PAPER ON WOOD-PAVING.

BY D. T. HOPE, ESQ., F.R.S.S.A., CIVIL ENGINEER, LIVERPOOL.

(Read before the Royal Scottish Society of Arts.)

THE excellency of wood, as a material for paving, is now so generally admitted, that it may seem unnecessary to inquire into the advantages it possesses over stone blocks and Macadamization.

And assuming the superiority of wood as sufficiently proved, by the rapid progress it has made in the public estimation, and the very favourable results of its varied applications in the most bustling thoroughfares of London, and some provincial towns in England,—the subject of inquiry may be usefully directed to the best position of the fibre of the wood,—its durability and efficiency as a material for paving, under wet, dry, and frosty weather; and into the value of animal power in draught on wood pavement.

The patentees of wood-paving are divided into two classes: one party for the fibre in a vertical position, and the other party for the fibre at *a particular* angle.

The general utility of the subject induced me to pay particular attention to it for some years back; and with the view of ascertaining the respective merits of the several descriptions of pavement and roadways, I made a variety of experiments on Macadamised roads and stone and wood pavements; on wood with the fibres placed vertically, and at angles from vertical to horizontal.

In the experiments on wood-paving (the results of which I now submit), the blocks were laid in the best manner, on the same sort of concrete substratum, and on the same line of road; so that all varieties had the same amount of traffic, and the same attention paid to their almost daily examination, for the space of eighteen months.

I. *On the Position of the Fibre.*

It will be quite unnecessary to notice the arguments that have been adduced to support the several systems in practical operation, being under circumstances, such as locality and traffic, which prevent comparisons being accurately drawn. These I have, however, guarded against, and the measurements taken were not of single blocks but of many.

I may here remark, that I am decidedly of opinion that a superior concrete substratum is absolutely necessary, and an essential feature in the successful application of wood for paving.

It appears, from careful observation, that the amount of wear is greatest in the first month, and gradually decreases every subsequent month. For instance, the wear from the first and second months is greater than any three months from the sixth. This, I think, can be very satisfactorily accounted for. Although the depth of the blocks diminished more in proportion for the first and second months, yet they did not seem to have lost much by abrasion. They had undergone compression, and presented a more compact surface than when laid down: and, besides being more compact in fibre, the surface was so impregnated with fine sand, that it had more the appearance of stone than of wood.

1. The vertical fibre blocks during the eighteen months were only diminished in depth, between compression and abrasion, ·125, or ⅛th of an inch. The blocks at the end of that time were in as good condition as if they had not been exposed to heavy weights and abrasion.

2. The blocks with the fibres leaning at an angle of 75 degrees, showed the additional wear of ·022 at the end of the eighteen months, which is the 40th part of an inch more than if they had been vertical. The surface showed a greater abrasion of the soft fibres, and the resinous fibres were slightly pressed to the leaning side.

3. The next are those with the fibre at 60 degrees. At the end of the first month, the diminution in depth was ·032, nearly double that of vertical; and at the end of the eighteen months they were diminished ·182, which is about 5-16ths of an inch; clearly showing that blocks at that angle must lose 1-16th of an inch more than vertical blocks. The surface was not so regular as the preceding, occasioned by the larger circles of soft fibre sustaining greater abrasion, and these as well as the smaller circles being unable to resist so much pressure at that angle, were so squeezed as to lose their cohesion on the immediate surface; and the resinous fibres being also unable to resist pressure at that angle, instead of protecting the softer, were leaning on them, and to a small extent showed a tendency to separate into threads.

4. The blocks with the fibres leaning at 45 degrees, lost rather more at the end of one month than the vertical did at the end of three months; and at the eighteen months about double what the vertical sustained. The surface was very much like the preceding, but the soft fibres had suffered more abrasion, and the resinous were separating into threads nearly ⅛th of an inch.

5. The blocks with the fibres at 30 degrees lost more in one month than the vertical did in six; and at the end of the eighteen months, 3-16ths more than the vertical. The surface was similar to the last, but to a greater extent.

6. The block with the fibres leaning at 15 degrees, lost as much in one month as the vertical did in ten; and in eighteen months full 3-8ths of an inch, being three times more than the vertical. In proportion to the angle, the surface was getting more unequal, suffering greater abrasion, the threads becoming longer and irregular, and the general appearance showing that destruction was making rapid progress.

7. The last to be noticed are blocks with the fibres horizontal. For the first month the wear was equal to fifteen months of the vertical, and in eighteen months they lost about half an inch. The fibres were completely separated to a considerable depth, and the surface had the appearance of a heap of broken strings.

II. *On the Durability of Wood as a Material for Paving.*

It seems indeed strange, that such incompressible and durable substances as basalt and granite should be more subject to wear, with the same amount of traffic, than wood with the fibre presented to the pressure and percussion. The former, however, when acted on by the wheels and horses' shoes, resist the pressure and percussion, and thereby have their particles abraded into a very minute sand; and the iron is also subjected to a diminution in proportion to the hardness of the stone.

On the other hand, wood, from its elasticity, yields to the pressure, and permits the weight to pass over it without any sensible injury to either the iron or wood.

III. *On the Efficiency of Wood for Paving, when necessarily subjected to Wet and Dry Weather.*

It is now sufficiently established, by men of maritime experience and ship-builders, that those parts of a vessel which are constantly exposed to the water, are never found to be the least affected, while other parts of the same vessel are undergoing rapid decay; and that decay is even arrested when it reaches the same seasoned parts.

Wood blocks in pavement may thus be said to be quite exempt from the probability of decay, even although they should be perfectly dry when laid down (a condition to be particularly recommended). They are placed on a humid, or what will soon become humid, substratum, closely packed to each other, and totally excluded from atmospheric influence, saving the surface. In wet weather they absorb as much moisture as they can contain, which renders them more adhesive and compact; and from which moisture they are never after totally free, even in the dryest weather; for wood being a bad conductor of caloric, any variation of the atmosphere has little effect on the blocks, or the surface exposed to it.

To prove this, I weighed a number of the blocks when laid down; and, after having been in use till properly moistened, had them

taken up and re-weighed, when I found that they had gained by moisture $4\frac{7}{8}$th ounces. After a long continuance of dry weather, I had them again taken up and weighed, and found that they were still moist, having lost only $1\frac{7}{8}$th ounce. I also split some of the blocks, and found that they were moist to the core, except about an inch from the surface, but regained that moisture towards the evening. I tried this experiment frequently, with similar results. The small difference in the size of the blocks, under various degrees of temperature, also bears out these experiments. The medium variation I could discover in their volume was ·057, which I attributed to the loss or gain of moisture; and this trifling difference of volume did not affect the adhesion of the blocks, or the general structure, in consequence of the moisture they retained in dry weather still maintaining an excess of volume over the dry state in which they were originally laid down.

To discover if it was from the exclusion of atmospheric influence that the moisture was retained, and occasioned their limited expansion and contraction, and not any peculiarity of the wood of the precise blocks used, I found that, in wet weather, blocks, when taken out and kept singly, expanded as freely as those used for comparison; and when they became the exact weight they were when taken out in dry weather, their volume was proportionally greater; and when kept till perfectly dry, they were reduced to their original dimensions.

I also found that the moisture contributed much towards imparting additional strength to the fibres of the wood, and rendering it more capable of resisting pressure and abrasion, besides preserving it from dry rot.

IV. Having glanced at the durability of wood under wet and dry weather, the next thing to be considered is the effect which frost has upon it.

In Russia, where the climate is so rigorous, frost might be supposed to be an insuperable objection; but when we find that it was in that country, some centuries ago, where wood paving was first adopted, and that a system not inferior to what is practised here, has been there for many years in general use, we may consider that, in the mild climate of Britain, where frost is neither severe nor of long duration, it can only be of trifling consequence.

In Russia it is admitted that frost has a deleterious effect on the wood,—to counteract which, they give it an annual coating of tar covered with sand, which, with other advantages, obviates any excess of slipperiness.

I found that the surface coated with common varnish and sand was highly beneficial. It preserved a more uniform temperature (although, as I have stated, the want of this greater uniformity is not objectionable), and rendered the surface rough and less slippery in frosty weather.

Laying aside this additional surety, in the course of two winters, I could find no other objection to frost than the slipperiness; but which, from the sand introduced between the fibres, and the grooving, was really no worse than on any other pavement; and even less than on a smooth macadamized road. And, in regard to the effect on the timber, I could discover nothing that was injurious, for the frost did not penetrate deep, and I did not find that the substratum was frozen at all.

V. *On Traction on Wood Pavement.*

Wood is eminently superior to any other material which has yet been employed for enhancing the value of animal power in draught, from its elasticity, and its peculiarity of maintaining, in all seasons and conditions of the weather, the same compact and even surface.

Besides the absence of surface resistance on wood, the power of the horse is materially increased when acting on the elastic surface. The resistance which the foot of the animal meets with on stone pavement is communicated throughout its whole body, reducing its power of action at the time, as well as the duration of its working life. But in wood pavement this resistance is partly borne by its superior elasticity, which receives a portion of the shock, and diminishes the injurious effects of percussion on the hoof. The muscular energy of the animal is in proportion saved—the abrasion of the pavement is reduced—and the wear and tear of carts and vehicles is diminished.

To ascertain the weight which a horse could draw, with the same exertion, and at the same rate of speed, of a macadamized road, on granite, and on wood pavements, I found the following to be the proportions deduced from a variety of experiments:—

	Cwts.
On granite pavement, ...	28
On a macadamized road, . . .	$34\frac{1}{4}$*
On wood pavement, ...	50

From the foregoing experiments it may be inferred,—

That verticality of fibre is the most durable position of wood for paving, besides affording the means of obtaining as firm a structure as is requisite.

That wood is an efficient material for paving, whether subjected to wet, dry, or frosty weather.

That the moisture it constantly retains increases its strength, preserves it against dry-rot, and undue expansion and contraction.

That wood for pavement is more durable than granite.

That the value of the horse is materially enhanced, and its power in draught considerably increased, on wood pavement. And,

That, with its general adoption, steam power may be successfully employed.

PAPERS READ BEFORE THE INSTITUTION OF CIVIL ENGINEERS.

Observations on the periodical Drainage and Replenishment of the subterraneous Reservoir in the chalk basin of London. Continuation of the paper read at the Institution, May 31st, 1842. By the Rev. J. C. Clutterbuck, M.A.

The author commences by answering an objection founded upon a passage of Conybeare and Phillips' Geology (Book 1, Chap. IV. sec 11), which was urged against his former statements.

The water, it was said, appeared to rise in different places to different heights—at Mile End it stood at the level of high-water mark in the Thames; at Tottenham 60 feet; at Epping 314 feet; and at Hunter's Hall, two miles beyond Epping, at 190 feet above that level. Especial stress was laid on the height to which the water was supposed to have risen in the well at Epping, namely, to within 26 feet of the surface, and to 314 feet above high-water mark. It appeared from a note appended to the statement referred to, that the first 27 feet from the surface of this well consisted of gravel, loam, and yellow clay, and that after sinking 200 feet, and boring 220 feet, as no water was found, it was considered a hopeless labour, the boring was discontinued, and the well covered over; that at the end of five months, it was found that the water had risen to within 26 feet of the surface; from which it might be inferred, as was afterwards proved, by information obtained from the owner of the well, that this supply of water was to be attributed to a landspring, and was not derived from the sand of the plastic clay formation, to which the boring had not penetrated.

Having thus answered this objection, it is shown that a line drawn from the water level at Hunter's Hall to mean tide level in the Thames, 10 feet below high-water mark, would cut the level in the other wells, and give a water level dipping at an average inclination, very nearly coinciding with that insisted on in the statement to which the objection was raised. It appeared that the difficulty of determining the exact dip of the water level between the river Colne and London, had in some measure been removed, by the sinking of three wells in the direct line of the author's observations, namely, from the river Colne one mile N.E. of Watford, in a straight line to Edgware, and thence by the high road to London; the information thus obtained, proved the general correctness of the author's former calculation as to the line that would represent the natural water level.

It is then shown that a line drawn from a point 3 miles south of the Colne, at the level of that river, or 170 feet above Trinity high-water mark, to mean tide level in the Thames below London Bridge (a dip of about 180 feet in 14 miles, or an average inclination of 13 feet in the mile) cuts the water level at the point whence it is drawn, at Hendon Union Workhouse, and at Cricklewood, between that place and Kilburn, whence it may be inferred that up to this point there is no apparent trace of a depression of level caused by the exhaustion of water under

---

* The weight on the macadamized road cannot be considered as a constant quantity, the quality of the surface being so subject to variations; for instance, the power will draw on a macadamized road,

	Cwts.
Smooth and consolidated, . . .	$34\frac{3}{8}$
After a shower of rain, ...	$30\frac{1}{4}$
During a continuance of wet weather, .	$23\frac{3}{4}$
Laid with new metal, ...	10

London. At Kilburn, the water level (which is known to have stood some years since about 20 feet higher than at present,) is considerably depressed below the line so drawn, which depression may be attributed to the influence of the London pumping—it is suggested, that it is desirable that the wells on the confines of London, and throughout the district, should be periodically measured, to ascertain to what distance, and in which direction, this yearly increasing depression may be found to extend.

The author proceeds to describe a phenomenon connected with the periodical replenishment of that portion of the London basin which underlies the London and plastic clays, and which cannot, as in the upper or chalk district, be fed by infiltration. This phenomenon is by him called the "oscillations of the water level," caused by the irruption of rain water, which runs from the surface of the London and plastic clays, and which sinks into the subjacent chalk through "swallow holes," on its arrival at the outcrop of the sand of the plastic clay formation. This point of irruption lies to the southward of the river Colne, and forms the line of demarcation between the clay and chalk portions of the surface of the London basin, leaving a belt of the latter varying from two to three miles, or more, in width, between the river and the outcrop of the clays.

The water level rises to a point within the outcrop (called the fixed summit level,) at an angle of not less than 10 feet in the mile, when most depressed by the springs; below an angle fixed on as the lowest line of inclination to which the water in the chalk will fall. From the fixed summit the level declines towards London; in the line taken, it is found at the level of the Colne, 3 miles from the river. After heavy rains, when the clays throw the water from their surface, the irruption of water may be seen at the outcrop of the sand of the plastic clay formation; the level will then be raised in proportion to the quantity of water which passes through the sand into the chalk beneath it, the elevation of level extending towards the river in a ratio increasing with the distance from the river; the fixed summit will remain unaltered, until the level at the point of irruption has attained an elevation at which the water can flow towards the south. After a period of protracted drought the level will decline in the same ratio as it had risen, until it assumes a line in which little or no variation can be traced.

In a given line from the Colne at Watford, to the village of Bushey, one mile and a half distant in the autumn of 1841, the level was found to rise from the river, at a regular inclination, to a point within the outcrop of the clays. After heavy rains, the level near the swallow-hole, which receives a large body of water, began to rise rapidly, the fixed summit level not being affected till the level, at the point of irruption, rose above it; the total rise at the point of irruption was 20 feet, and at the fixed summit 2 feet. The position of the summit level had then varied from the fixed summit to the point of irruption; coincidentally with this elevation the level under London rose also, and began to decline at the same time that the level, at the point of irruption, sank below the fixed summit. The subsidence of the level at the point of irruption, was,—in April, 4 feet; May, 3 feet; June, 2 feet; July, 1 foot; August, 9 inches; September, 6 inches; in October, and to November 8th, 1½ inch; the average inclination, from the fixed summit to the river, then being about 15 feet in the mile. The subsidence of the level to this inclination, was coincident with a visible defalcation in the product of the springs discharging themselves into the river Colne. In the autumn of 1842, and in the preceding spring, similar effects were observed, both as to the rising of the level at the point of irruption, and the coincident elevation of the level under London. This oscillation of level has been traced at various points, both to the east and west of that here described.

It is probable that, near the junction of the Colne and the Ver, the level dips directly from the level of the latter river, at a point where the plastic clay extends itself under the Colne to the margin of the Ver. This suggests the probability of that to which the author alluded in his former communication, namely, the possibility of connecting a periodical defalcation observed in the waters of the Ver or the Colne, at those seasons when the water is short, with the exhaustion of water under London. The evidence in favour of this supposition has been strengthened, during the past year, by a repeated coincidence of variation in the London level with the supply of water in the river. The height of the water in the river (about 210 feet above Trinity high-water mark), gives the same average inclination of level towards London as observed in other places, and strengthens the probability that the supply of water to the river may be affected at this point by the London pumping, the daily increasing demand of which will, if (as is contended) there be any ground for this supposition, very soon put this question beyond a doubt.

Mr. Dickinson said, that Mr. Clutterbuck's observations had been caused by a project for obtaining a supply of water for the metropolis, from wells to be sunk in the valley of the Colne. It had been stated, in support of the plan, that the rapidity with which the rain water percolated into the bowels of the earth in a great measure prevented evaporation, and hence it might be assumed, that the quantity which descends upon the surface of the chalk found its way, with very slight diminution, into the fissures below. This reasoning was not in accordance with the deductions Mr. Dickinson had drawn from an extended series of observations, and, fearing that his mill property might be injured by a diminution of the supply of water, he had opposed the project.

He had found it necessary, several years since, to investigate strictly the nature and extent of the supply of water to the springs and rivers of the chalk district, for which purpose he had a common rain-gauge, which was corrected by observations upon that kept in the same district by the Grand Junction Canal Company: he also fixed a rain-gauge on the principle suggested by Mr. Dalton, which demonstrated the quantity or proportion of the rain falling on the surface, which descended so far into the earth as to be beyond the reach of evaporation, and, therefore, must be calculated to reach the internal reservoir of the country whence the springs were fed. This gauge demonstrated that the greater part of the rain that fell on the surface, was either consumed by vegetation or evaporated. It furnished information of the most valuable kind, both as regarded his mills and business, and as to any engineering operations, having reference to the perennial supply of water in the springs and rivers of the district.

Mr. Dickinson presented the following statement of the comparative result of his two gauges for the last eight years, pointing out, as was generally the case, that none of the rain-water penetrated to the springs between the 1st of April and the 30th of September. He also stated that the indications of the gauge were not only certain, but that they preceded generally by about two months any thing that could be deduced from the observation of wells, with reference to the effect upon the rivers; and that, as to the latter, the only guidance to be derived from the state of the wells, was from those in the higher range of the chalk, because, along the valleys where the streams flowed, the level of the wells continued nearly the same throughout the year.

MONTHS.	1835—1836.		1836—1837.		1837—1838.		1838—1839.		1839—1840.		1840—1841.		1841—1842.		1842—1843.	
	Com. Rain Gauge.	Dalton Gauge.	Com. Rain Gauge.	Dalton Gauge.	Com. Rain Gauge.	Dalton Gauge.	Com. Rain Gauge.	Dalton Gauge.	Com. Rain Gauge.	Dalton Gauge.	Com. Rain Gauge.	Dalton Gauge.	Com. Rain Gauge.	Dalton Gauge.	Com. Rain Gauge.	Dalton Gauge.
September	3·82	·21	2·60	·07	1·38	·05	2·47	·03	3·22	1·50	2·31	—	4·00	—	4·50	1·30
October	5·96	4·75	4·55	3·82	1·55	·02	2·68	·07	1·68	·09	1·50	—	4·40	5·99	1·41	·30
November ..	2·10	2·17	3·95	3·14	2·05	·18	3·55	2·91	4·40	4·70	4·25	2·57	4·28	4·87	5·77	5·00
December ..	·24	·48	2·21	1·72	1·70	1·62	1·58	1·84	3·02	3·75	·40	1·57	2·30	2·80	1·52	·84
January ...	2·40	2·32	2·40	2·10	·31	·04	1·40	1·04	3·95	3·05	1·50	—	1·36	·60	1·46	1·25
February ..	2·04	2.04	2·85	2·92	2·65	·86	1·45	1·51	1·32	1·00	1·02	—	2·02	2·10	2·32	1·95
March	3·65	2·51	·75	·01	1·55	2·73	1·92	1·22	·34	—	1·65	·53	2·20	1·62	·88	—
April	2·57	1·74	1·32	—	1·35	—	1.65	·71	·34	—	1·85	—	·47	—	2·10	—
May	·70	·03	·94	—	·84	—	1·22	·10	2·62	—	1·68	—	1·85	—	—	—
June	1 80	·01	1·86	—	2·85	—	3·31	·05	1·33	—	3·00	—	2·00	—	—	—
July	2·29	·10	1·30	—	2·35	·09	4·36	·15	1·18	—	2·80	—	1·93	—	—	—
August	2·24	·15	3·00	·05	·95	—	3·65	·09	1·90	—	3·62	—	1·40	—	—	—
	29·81	16·51	27·73	13·83	19·53	5·59	29.24	9·72	25·30	14·09	25·58	4·67	28·21	17·98	19·96	10·64

Mr. Clutterbuck perfectly agreed with Mr. Dickinson as to the satisfactory results yielded by Dalton's rain-gauge; but he had, from the first, expressed an opinion, that the same practical results might be obtained by a periodical measurement of the wells, in any part of the chalk district. If a line was taken, extending from the river or vent to a point midway between the rivers Gade and Ver, or any others, and observations made during different periods of the year, and the same periods of different years, the height to which the water rose or fell, would indicate the quantity which had actually percolated to the water-level, and would give the relative quantity to be delivered out by the springs. The ratio of alternation throughou the line would be maintained with such undeviating regularity, that by the measurement of the wells at the two extremes, the rise or fall of all between them might be calculated with the greatest exactness. He had chosen, by way of illustration, a portion of the line, of which a section, three miles in length, was given, extending in a direction north and south between the rivers Gade and Ver, a locality whence a considerable portion of the water, which in part moved the machinery at Mr. Dickinson's mills, was derived. He took the seasons which govern the supply of water, as shown by Dalton's gauge. In the seasons 1840—41, the gauge indicated the percolation of less than 5 inches of rain, a quantity which must be far short of that which found its way to the water-level. The gauge recorded no percolation of water immediately after the melting of the snow on the 16th of January, 1841, within a month of which time the level rose in some localities more than 15 feet. To make a proper estimate of the quantity of water to be delivered from the springs, it was necessary to ascertain the state of the level before the percolation commenced; to this the rain-gauge was no guide; but by Mr. Clutterbuck's observations he was enabled to determine the exact relative depression of the level. The first day taken was September 13th, 1841, between which period and November 8th, the level rose at one point 18 feet, and at other points in due proportion, which distinctly proved that "the indications of the rain-gauge do not precede by two months any thing that can be deduced from observations on wells." His next observation was February 14th, 1842, showing the highest point at which he measured the level, giving a total rise of 34 feet, though from observations elsewhere it must previously have risen even higher, and have fallen to that point in consequence of the accelerated drainage caused by the breaking out of springs at higher levels, when the water in the chalk attained a certain elevation. On the 7th of May the level had fallen considerably, and on the 24th of October had declined to within a few inches of the same level as in the September of the previous year. In the season 1841-42, Dalton's gauge indicated the percolation of 17·98 inches of rain; in 1842-43, 10·64 inches: but from the causes before alluded to, and from the rain not having percolated till a later period, the level continued to rise till May, consequently the quantity of water then in the chalk was greater in proportion, than as 10 to 17. He conceived that the great practical question was, what supply might be reckoned upon from the 1st of May to the end of October? The reply to this was, he contended, more distinctly given by his observations than by the indications of Dalton's rain-gauge. With reference to the rapidity with which the water found its way from the surface to the level, except when there was a great quantity of rain within a very short period, the percolation would be gradual, as indicated by a steady and progressive rise in the wells, which he had ascertained to amount sometimes to 1 or 2 inches in a day in the upper district, and continued generally to the beginning of May. In the neighbourhood of the swallow-holes the level rose very rapidly: a well sunk 50 feet in the chalk, in which the water stood at 40 feet from the surface, was affected within 15 hours after a late heavy rain commenced; the quantity of rain, which amounted to 1 inch in 12 hours, appeared to have retarded by a fortnight the exhaustion of that portion of the level to the south of the Colne, which is fed by the irruption of water through the swallow-holes. On a former occasion, between the 10th and 25th of November, 1842, there fell on the surface 3·88 inches of rain; the level near the swallow-holes rose 6 feet within the same space of time. When the water had reached the level, the influence of one part on another was very rapid: thus when the distant level was raised, as Mr. Clutterbuck had described, there was a simultaneous rising of the level under London. The continuity of the level, as shown in his section, was the best evidence in favour of the supposition, that the water to London was mainly supplied from the source to which he had attributed it. He had not met with any evidence in favour of the supposition that a distinction was to be drawn between the water from the chalk and that from the sand; he believed that it was all derived from the chalk, whence it rose into the sand, to which there appeared no impediment. At the points where the water broke through the sand, it invariably sunk into the subjacent chalk, a space being left between the bottom of the sand and the top of the water; following the water-level, it might be traced in the chalk, and rose into the sand when the surface of the chalk sunk below the inclination at which the water-level dipped towards London; from whence he inferred that the whole level of water might be called the "Chalk-water level."

Mr. Simpson reiterated his opinion respecting the waters in the sand and in the chalk being different. He had seldom found the water from those strata stand at the same level, and in the majority of instances, the water from the chalk rose to higher levels than that from the sand. Towards the west of London, prior to 1830, there were numerous cases of overflows from bore-holes; and he believed, from an account drawn up by him from actual inspection of the wells when they were sunk, or soon afterwards, and which he presented to the Institution, it would be found that in the majority of instances of overflowing wells the water proceeded from the chalk.

This paper gave an account of sixty-seven wells, detailing in several cases the various strata passed through, and, in all, the total depth, the levels at which the different qualities of water were met with, the quantity of water yielded, and the height to which the main supply rose in the well. He had found from recent inquiries, that in many of these wells the water had now ceased to overflow. It would appear that, as the number of wells and bore-holes had increased in some districts, the water levels had been depressed; in several cases, the cause of this had been traced to wells which had been bored at extremely low levels, and in others to the increased pumping.

Messrs. Worsencroft and Brothwood, of Hammersmith, who practised well-sinking extensively some years since, were most successful in wells where their competitors had ceased working when they had pierced some distance into the sand strata, whence the water only rose to some distance beneath the surface; but by continuing the boring down into the chalk, they obtained overflowing wells.

Mr. Scanlan said that the difference between the water from the two strata was easily discovered by analysis: the water from the sand contained common salt and no lime, while that from the chalk contained lime and no common salt.

Mr. Clutterbuck said, in answer to Mr. Simpson's objection as to the identity of the chalk and sand water-levels, the disparity of level that he spoke of, occurred in localities where there was an exhaustion by overflowing Artesian fountains, in which case a discharge of water was created below its natural level, which would cause the same kind of depression either in the sand or the chalk, as that which was caused by pumping the same quantity of water from a corresponding level where the water would not flow above the surface; the only difference being, that in the former the depression was permanent, and in the latter it was coincident with the temporary exhaustion of the pumps. As the water was discharged from the Artesian fountains more rapidly than it rose through the sand from the chalk, a permanent depression took place in the wells sunk into the sand, whilst a lesser depression occurred in the chalk, and thus caused a disparity of level. Thus, the water level in the wells sunk into the sand in London, was temporarily depressed by pumping from others in the neighbourhood, and the level was regained when the pumping ceased.

Mr. Braithwaite eulogized the industry and observation of Mr. Clutterbuck, and he hoped that he would extend his investigations to the point of the outcrop of the basin of the river Thames, which he had stated to be near Woolwich. He must, however, dissent from the author's views as to the supply of water under the plastic clay being derived from the chalk, and also, that if no rain fell during a period of three years, the water in the wells referred to in the section would retain their relative levels, at an inclination of not less than 10 feet in a mile. He believed that any continuation of dry weather, which would affect the land-springs, would also diminish the filtration, and the upper part of the basin on all sides would be affected before the greater depths.

Mr. Braithwaite also differed from Mr. Simpson as to the supply for the overflowing wells at Kingston, Mitcham, and other parts, being from the chalk; on the contrary, he was of opinion that it proceeded from the sand under the plastic clay, and he instanced Mr. Palmer's will at Kingston, and that sunk by Mr. Clark at the Kingston Union. The latter well was within 100 yards of the former: it was 420 feet deep to the sand-spring, and the water rose to within 7 feet from the surface. While the water stood at this level in the well at the Union, it overflowed at Mr. Palmer's; but when the level at the Union was reduced by pumping to 20 feet from the surface, the water in Mr. Palmer's well ceased to overflow: thus, he contended, establishing the fact, that the water in both wells was derived from the sand, and not from the chalk.

Mr. Clutterbuck observed, that the reason why there was a depression observable at Kilburn, and not at Cricklewood, was easily explained, if the depression caused by the pumping in London was laid down on a diagram. In the centre of London the depression amounted to 50 feet below Trinity high-water mark; at the Hampstead-road, to 38 feet; and at the Zoological Gardens, to 25 feet. This line, if produced, would show a depression below the natural water level at Kilburn, and fall into the non-depressed level about Cricklewood. Though it was impossible to prove the assertion, that the water level in the chalk would never assume a less inclination than 10 feet in the mile, he was led to the supposition by observing that the level ceased to decline when it became depressed to that extent; and many wells at a distance from the vent,

which at the time of such depression contained only 3 feet of water, were never known to become dry.

Mr. Clark stated that he had found the water rise from the chalk to very different levels in the various wells and bore-holes which he had sunk, and he had not observed that the supply of water was affected so immediately after rain as had been described by Mr. Clutterbuck. He presented a paper containing memoranda relative to wells sunk and bored for a considerable distance on both sides of the river Thames. This document gave the depths at which the chalk was arrived at and the water was found, and the height at which it stood in several wells around London. It stated also, that in London the average depth to the chalk was 220 feet; that the water generally rose to within 70 feet of the surface, but that near the river it rose to within 50 feet. In some particular cases, such as the Lunatic Asylum at Wandsworth, the depth to the chalk was 323 feet, yet the water rose to within 30 feet of the surface.

Mr. Davison presented a copy of a drawing made in the year 1822, showing the depth of sinking and of boring, and the height to which the water rose, in ten of the principal wells in London at that period, which it was remarkable was exactly Trinity high-water mark. It appeared also that the water did not now rise in the same wells to within 50 feet of that point, showing a depression of nearly 2 feet per annum.*

"I consider the series of observations he has been making near Watford, to be very important, as throwing light on the movement of the subterraneous sheets of water which supply springs and rivers. I believe these observations to be correct, as I know that he has been indefatigable in collecting facts, and I consider them calculated to illustrate a problem of high interest to Civil Engineers as well as to Geologists."

Description of an improved Form of the Journals of the Axles for Railways.
By Captain Elias Robison Handcock.

The paper commences by enumerating the principal disadvantages of the common railway axles, noticing particularly the great consumption of oil; the wear and tear, not only of the axles, but also of the boxes and the brasses; the oscillation occasioned by the wearing away in length of the latter, producing destructive effects alike to the engine, carriages, and rails, as well as being disagreeable to the passengers.

It then describes the new form of axle, which it is contended is calculated to remove these evils. The chief peculiarities of its form, consist in substituting for the abrupt shoulder at either end of the journal, two cones; the outer one, which is loose on the axle, is capable of being forced forward by a screw on the extremity; it is prevented from revolving on the journal by means of a tongue, and is secured by a screw-nut and key. The two antifriction collars of hard brass, which take the places of the ordinary journal brasses, are about $\frac{3}{8}$ths of an inch in thickness, and are fitted on the journal sufficiently loose to enable them to turn freely in the bored cast-iron boxes which support them; these collars extend over both the cones, and along the journal till their ends meet within about a quarter of an inch in the centre, and acting as an independent moveable power between the journal and the cast-iron box into which they are fitted, they reduce the amount of friction when it becomes greatest. Among the advantages derived from this new form, are the uniform smooth and steady motion, consequently reducing the wear and tear; allowing the collars to be at all times tightened, avoiding the lateral action, which is detrimental to the carriages, and to the line of rails; the smaller consumption of oil; one pound of oil being sufficient to lubricate a six-wheeled engine and four-wheeled tender, while running a distance of nearly a thousand miles, and the absence of any tendency to heat. The paper concludes by expatiating on the benefits already found by experience to result from their use.

Captain Handcock exhibited the journal of a common railway axle, with its box and brasses, which had been in use, and pointed out that the principal abrasion had taken place at the ends, that a new brass for the same journal would require to be nearly an inch longer, and therefore, that the oscillation of the carriage must necessarily be great, whenever the brasses began to wear. He explained that it was usual, in order to save the expense of new brasses, to weld an iron ring upon the journal against the collar, and showed one, which had worn such a cavity in the end of the brass, as to bury itself completely within it. It appeared also that there was much wear both on the journal and in the box, and that unless an axle possessed the means of having its brasses tightened up endways, oscillation and abrasion were inevitable. A journal and its cones of the improved form, which had run over 21,000 miles on the South-Western Railway, exhibited no visible amount of abrasion, and Captain Handcock contended that the practice confirmed his previous ideas.

Mr. Field thought the form of the axles a decided improvement. They were somewhat on the principle of those which had succeeded so well for common roads, and he believed that they must prove of considerable advantage for railways.

Mr. Fairbairn approved of the construction of the journals, and had no doubt of their practical efficiency; he particularly liked the cones, as in addition to their affording the means of preventing lateral motion and diminishing the friction, their form added strength to that point near the shoulder where it was most wanted.

Captain Handcock stated that the average consumption of oil on railways was for an engine and tender with common axles and brasses, about 6 lbs. for 110 miles; of this quantity, 2 lbs. were used for lubricating the axles.

General Pasley observed that his attention had been drawn to these axles, and although, on account of his official position, he scrupulously avoided giving any opinion on the merits or demerits of an invention, yet he might say that if he was a proprietor of a railway, such was his opinion of Captain Handcock's axles, that he certainly would give them a trial.

* In a letter to the Secretary of the Institution, dated April 28, 1843, Dr. Buckland says, "I think that Mr. Clutterbuck has added many new facts in confirmation of the theory he maintained last year, as deduced from his observations previous to that time. He has also, I think, found a satisfactory solution of the apparent anomaly afforded by the well at Epping.

INSTITUTE OF BRITISH ARCHITECTS.

Tuesday, Nov. 6th; W. Tite, Esq., V.P. in the chair.

The minutes of the last meeting having been read, the chairman commenced the business of the Session in a short and appropriate address. He congratulated the members upon the increased attention paid to Gothic architecture, and the beautiful restorations of many of the finest remains of the middle ages. He at the same time cautioned the junior members against the neglect of the study of the classical styles. The architecture of Greece and Rome were better adapted for numerous modern structures than the Gothic, and should continue to be cultivated with zeal and perseverance. Nor should they neglect those great types produced by Inigo Jones and Sir Christopher Wren. In consequence of the efforts being made to introduce fresco painting, the attention of the profession had been much directed to the state of the decorative arts and architecture on the Continent. During the past summer he had spent a few weeks in Germany. The Walhalla, the theatre at Munich, and cathedral at Ulm, were alluded to as most elegant structures of their several kinds. The last mentioned building he considered one of the most light and elegant Gothic structures he had ever seen; and in this opinion Sir Robert Smirke agreed.

The prize for the drawings, having been awarded by the council to Mr. Andrew Johnston, was presented by the chairman.

A paper was then read by Mr. Donaldson, V.P., on the models of churches preserved in Henry the Fifth's Chantry, Westminster Abbey, and also a letter from Mr. Crace on modern frescoes. Both these papers are inserted at length in another part of the Journal. Mr. Donaldson exhibited an original drawing by Polidore, supposed to have been intended as a merchant palace for erection in Venice. We shall probably have an opportunity of presenting our readers with a copy of this design, and a few remarks upon the external decorations adopted in the island city.

Tuesday, Nov. 20th; W. Tite, Esq., in the chair.

A valuable practical paper on fir timbers was read by G. Bailey, Esq., Secretary R.I.B.A., which will be found in this number of our journal.

The paper having been read, the chairman stated that it was very desirable the members should discuss the subjects brought before them at the meetings, and invited their remarks. Such papers as that just read were exceedingly valuable to the architect, for it was only by close study and great experience, that many of the woods commonly employed could be distinguished from each other. The practice of a London architect frequently calls him into all parts of the country, and sometimes abroad, and he had found that in some parts timbers were employed, and customs adopted, unknown in the metropolis. He remembered, that when going over the Custom House in Liverpool, he was much struck with the appearance of the floor in the great room; he never saw anything more beautiful. Upon inquiry he found that it was Riga timber cut into the width of battens. In some parts of Scotland the yellow pine was used for joiners' work, and was polished, not painted. He had once an engagement in France, where flooring boards could not be obtained, and Memel timber was used.

Dr. Dickson considered the subject one of great interest to the architect. In Switzerland the Siberian stone pine, which grows to the height of 200 feet, is very commonly used. It might be a question worthy of consideration, whether a home supply might not hereafter be obtained from the estates of the Duke of Athol. In reference to the dry rot, he

thought much advantage might be derived from the use of the impure pyroligneous acid, which contains creosote.

Mr. I'Anson stated, that the Baltic timber is never without large knots, and when submitted to great weights, there is a liability to its breaking at the knot. The red pine is very strong, and has seldom any large knots.

BIOGRAPHY.

MR. JOHN BUDDLE.

The name of John Buddle is well known to the public as the agent and viewer of the Marquis of Londonderry, and the great improvements he has been instrumental in introducing into the working of coal, are familiar to all practical engineers. As a miner and geologist he has long held a high rank among scientific men; and the large body of evidence given by him before the Parliamentary Committees, and contained in the Reports, is constantly referred to as of the highest authority. The following brief account of this eminent man has been communicated to the *Times* by some of his friends.

"Mr. Buddle was the son of a colliery viewer of great eminence, who had the management for many years prior to his death of the most celebrated and profitable colliery ever worked in this country, namely, the original Wallsend colliery, belonging to the late William Russell, of Brancepeth Castle, and which has given a name to the best coals of the present day. The elder Mr. Buddle was a man of considerable literary and scientific attainments, and he bestowed great care in educating his son in every branch of knowledge which could be advantageous to him in his intended profession of colliery viewer and mining engineer. Mr. Buddle, therefore, was not originally a mere 'pit lad,' but, on the contrary, a well-educated gentleman from the beginning of his career; so well, in fact, had he availed himself of the excellent education he had received, that on the death of his father, in 1806, he was immediately placed by Mr. Russell at the head of his immense colliery concerns, and continued ever afterwards to enjoy the confidence of that gentleman and his successors. Mr. Buddle, by his industry and talents, had realised a large fortune before he became connected with the Marquis of Londonderry, the agency for whose mines was only one of the many lucrative employments held by this eminent individual. Mr. Buddle was also extensively engaged on his own account in collieries and shipping; and, in addition to his permanent agencies, he was almost continually employed in Parliamentary and other proceedings relating to mining property in every part of the kingdom."

The property left by Mr. Buddle is supposed to be equal to about £150,000.

MISCELLANEOUS.

Nene Estuary Embankment.—This extensive undertaking was designed for the purpose of enclosing from the sea a tract of most valuable land, amounting to about 4,000 acres, which will, when enclosed, be principally the property of the Commissioners of the Nene Outfall, under whose auspices the works are being carried into effect, and in which they are assisted by the professional services of Sir John Rennie. The embankment is nearly three miles and a half in length, and for some distance averages 28 feet in height, and at some parts of the line of works there is a depth at high tide of 14 feet. About one mile and three quarters, or one-half the whole length, is already completed. The land, it is estimated, will vary in value from 50*l.* to 80*l.* per acre, and, as a maiden soil, would be a fine site for a model farm of one of the agricultural societies of England. The works are rapidly progressing under the superintendence of Mr. H. H. Fulton, resident engineer, and the contract, we understand, was taken in August, by Mr. Sharp, for 60,000*l.* The Nene Outfall Commission, composed as it is of some of the most public-spirited men of the day, headed by Mr. Tycho Wing, as chairman, has already effected great improvement in the condition of part of the fens of Cambridgeshire and Lincolnshire, by procuring a natural drainage for the lands in lieu of the inefficient and expensive system of drainage by windmills and other mechanical means, at the same time improving the navigation of the river Nene from the sea at Wisbech to such an extent, that formerly Humber keels of 70 or 80 tons could with difficulty reach that port, whereas now vessels of 400 or 500 tons can, without the assistance of a pilot, owing to the straightness of the channel, get up to Wisbech without the slightest difficulty. This navigation, as an artificial tidal channel, is said to be the finest of that description in the country. It was designed and executed under the direction of the late Mr. Thomas Telford and the present Sir John Rennie, and so important has been the result of these works, that the trade of the port of Wisbech has been trebled during the last ten years. In the course of last year it amounted to 140,000 tons of shipping, though the shipping trade was in a worse state in 1842 than it has been for many years past.—*Times.*

Hungerford Suspension Bridge.—It is intended to open this bridge in May next. The abutments on either side of the Thames, and the pier on the Hungerford side, are completed. The pier on the Lambeth side is expected to be finished by Christmas. The length from pier to pier will be 600 feet, the entire length of the bridge from the abutments on the Hungerford side to the opposite will be 1,440 feet. Its breadth in the "clear" will be about 14 feet, and its height from the water level to the footway, 28 feet. The height of each pier, from its basement to its top, will be nearly 100 feet. The links that compose the supporting chains are made of malleable iron, 700 tons of which will be necessary for the construction of the bridge. The property required for approaches has cost £13,000, and a contract has been made for the completion of the bridge at a cost of £80,000. The total cost (including expenses incidental to the progress of the works, the act of parliament, &c.,) will be £106,000. The proprietors calculate that a net annual income of £8,010 will be derived from tolls, being at the rate of 8 per cent on the capital. 10,000 persons must cross the bridge daily to yield this sum.

Proposed Docks on the Cheshire Side of the Mersey.—The leading topic of conversation in Liverpool lately has been the avowed project of the commissioners of Birkenhead to construct a dock on the Cheshire side of the Mersey. It seems that the intention is not a new one, but has been cherished a considerable time, and the parties only waited until the corporation of Liverpool had disposed of their land there, or a portion of it, for other purposes, previous to announcing it to the world. At a recent meeting they came out with the startling intimation, that they had obtained the consent of the Admiralty to their enclosing the whole of Wallasey Pool, from the bottom of the Woodside Ferry to Seacombe,—an area of not less than 340 acres. It was intended to have gates, a tidal basin of 30 acres, 12 feet of water at all times of tide, for vessels to float in, and dock space to the extent of 120 acres: also an additional tunnel under the township, to connect the tunnel extending from the station of the Birkenhead and Chester Railway, at Grange-lane, with the dock. The cost of the work is estimated at near £300,000. All the pecuniary advantages derived from the dock are to be appropriated to the measure itself, and if ever, from the sale of part of the land or otherwise, any other revenue should arise, it is to go in the reduction, first of the dock rates, and afterwards of the cost of construction, until finally the dock should be open to the whole world free of charge. Plans had been prepared, sections taken, bearings made, levels obtained, notices ready, and everything in a state of forwardness. The law clerk was empowered to give the requisite notices in the next Gazette, preparatory to going to Parliament. Perhaps no business has ever been the subject of such general conversation as this has of late; and it is thought that it will entirely stay the further progress of docks at the south end of the town.—*Manchester Courier.*

The Plymouth Breakwater.—The last stone of the lighthouse tower, at the western end of this stupendous sea barrier, was set on Thursday last by the Rear-Admiral, Superintendent of the dockyard, Sir Samuel Pym, K.C.B. The tower is 122 feet in height from the level of the bottom of the sea, and 56 feet from the level surface of the breakwater. It is composed of 31 courses of large blocks of dressed granite, the first of which was laid by the late superintendent of the dockyard, Vice-Admiral Warren, on the 22nd of February, 1841. The lighthouse is divided into five stories, in which are an oil-room, a store-room, a dwelling-room, a bed-room, and a watch-room. It has 14 windows, seven of which are in the watch-room, the frames being constructed of bell-metal, as are also the outer doors. The lantern is the only thing now necessary to complete it for service, which it is expected will be ready to be brought into use early in the next year, when it will supersede the old light vessel, which has been moored in the Sound ever since 1813.

New County Gaol at Reading.—The new gaol for the county of Berks, at Reading, which is now in the course of erection at an expense of very nearly £33,000, is fast approaching towards completion. The whole of the internal fittings will be completed by the first of January next, when the prison in every department will be open for the reception of the county prisoners, a portion of whom are now in the gaol at Abingdon. The whole cost of the erection will be as follows:—The building, £28,226; the internal fittings, £3,273; and the fees to the architect, and the salary to the clerk of the works, £1,460; total, £32,959.